Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati

FIRST RESULTS ON GIN DETECTOR

A. Biondi, G. Dho, G. Mazzitelli

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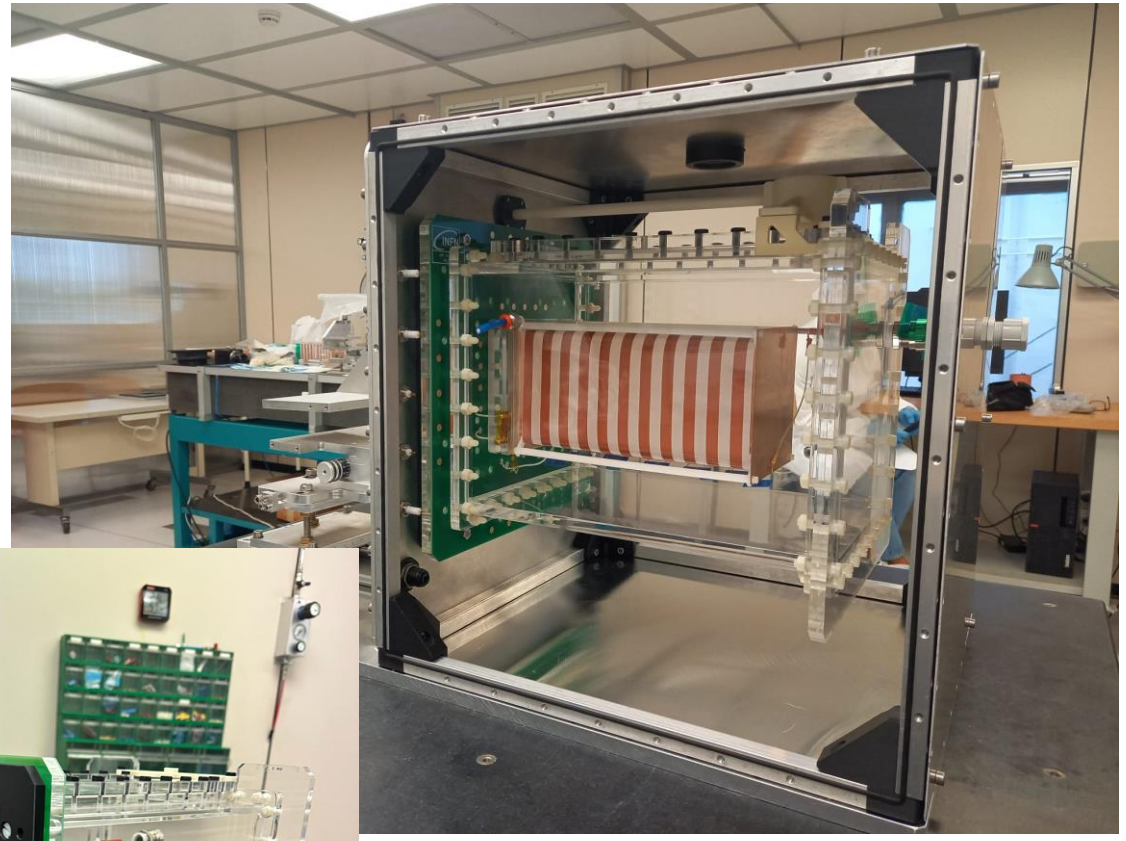
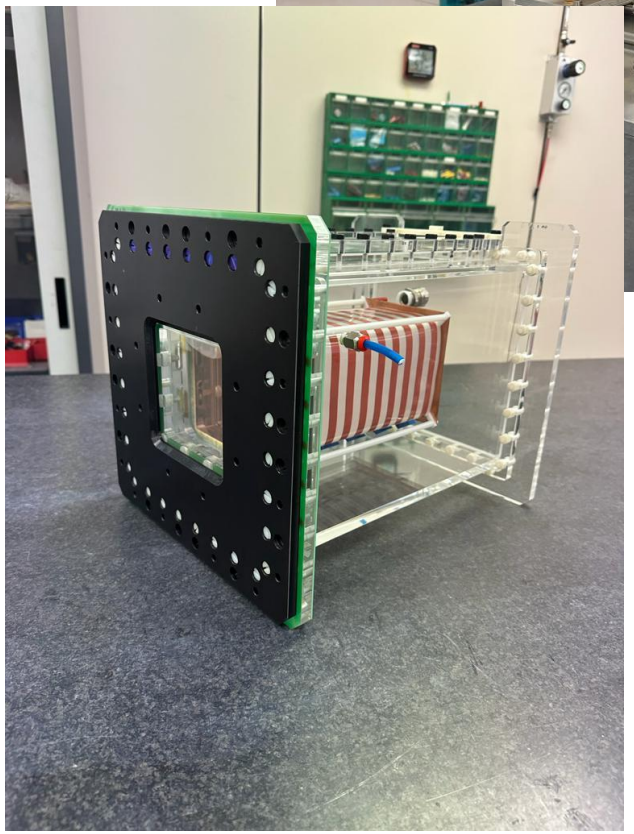
Goal of GIN

The GIN detector main goal is to test construction materials and instrumentation for Cygno-04, in particular:

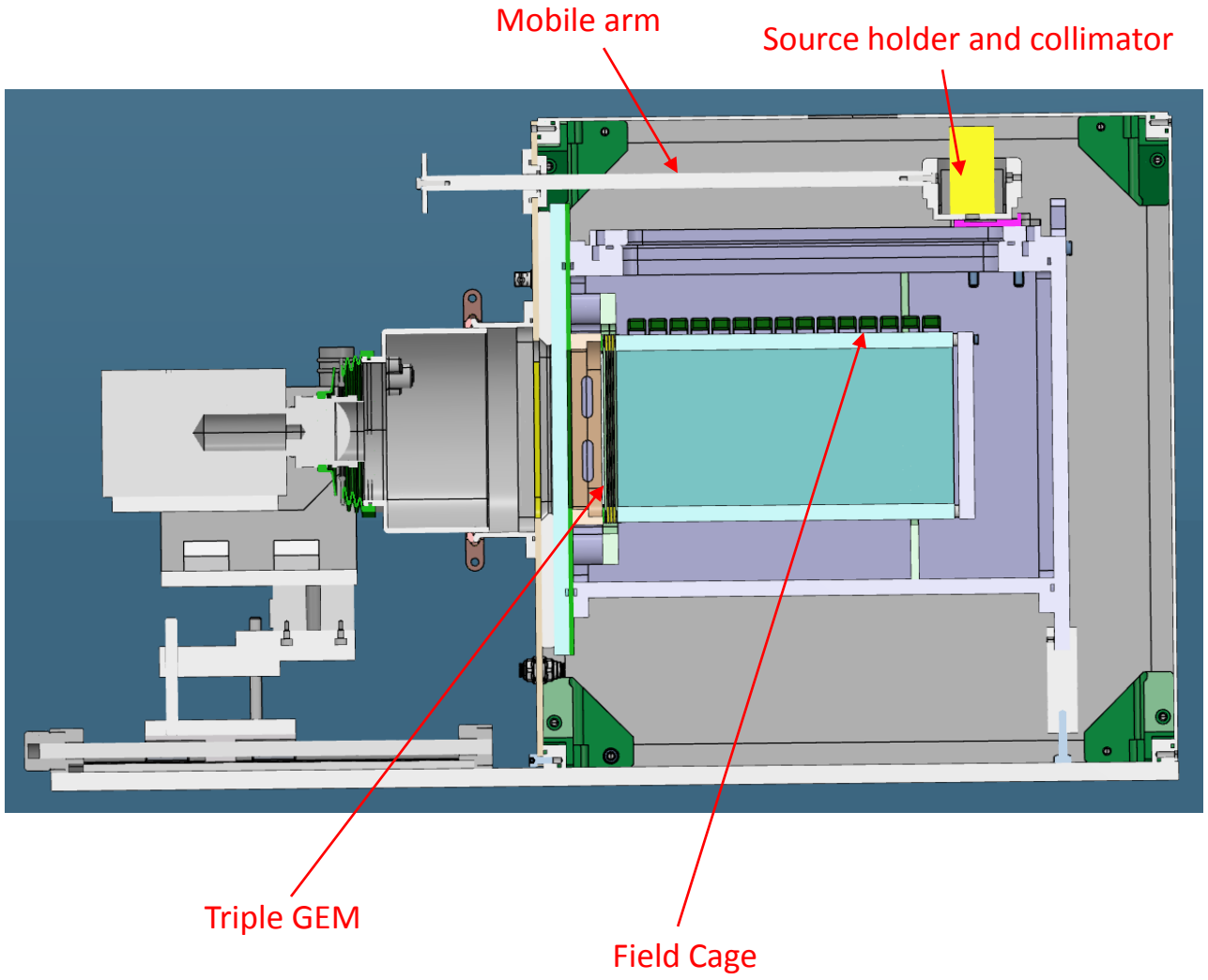
- Field Cage
- Cathode
- Gas Vessel





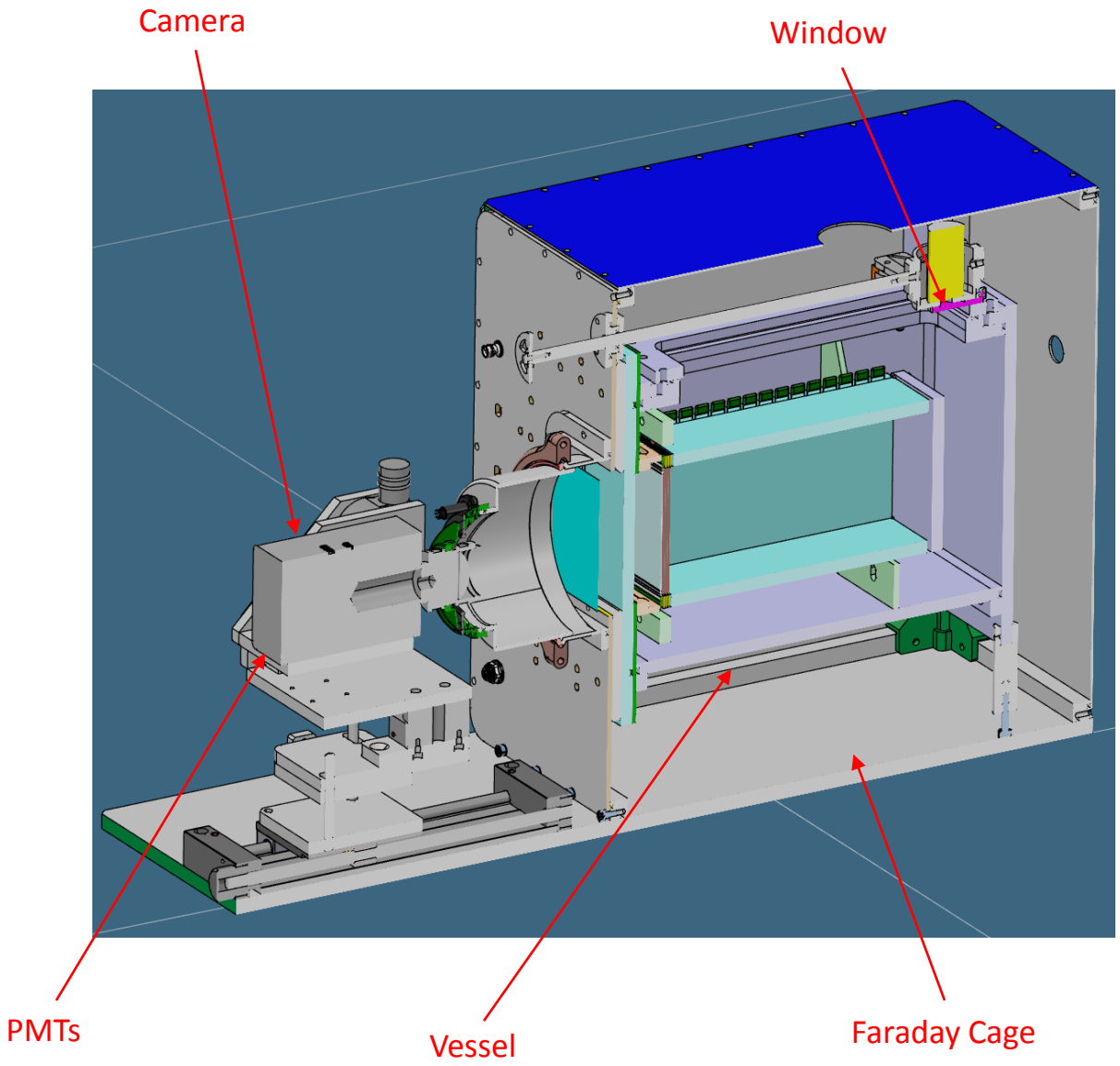
GIN Geometry I

- Field Cage in PVC and Copper of 11 rings of 1cm, total lenght 22cm.
- 10cmX10cm Triple GEM amplification
- Mobile source holder from 2,1 cm to 22,2 cm from GEMs
- Source Collimator of 3,6 mm width for Fe55 tests



GIN Geometry II

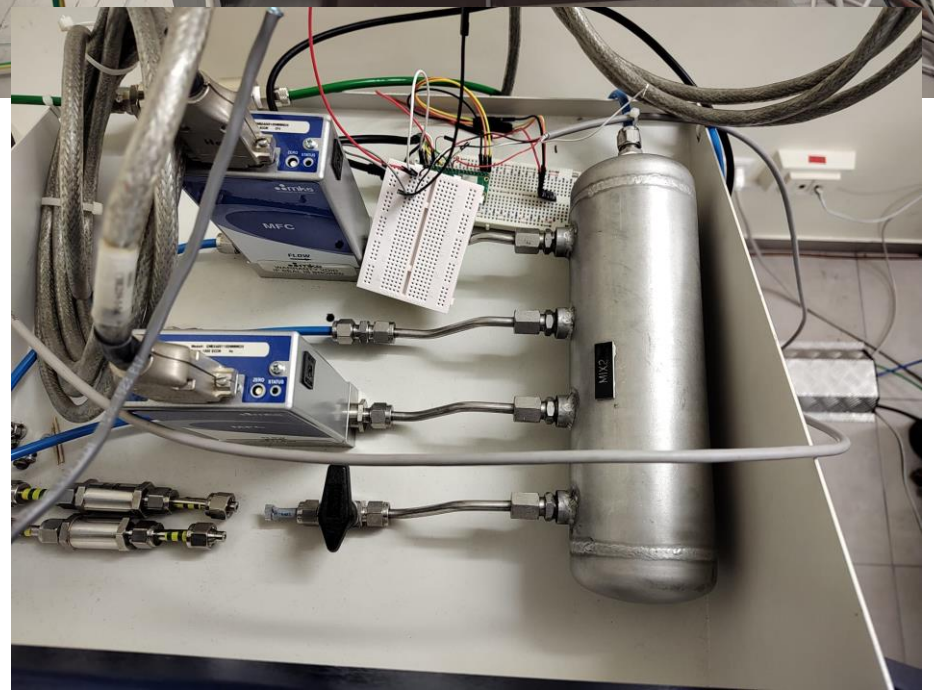
- Hamamatsu Camera C14440
- Two Hamamatsu R1894 PMTs along the diagonal
- Plexiglass Vessel of 22 x 22 x 30 cm
- Plexiglass Window at 42mm from FC
- Faraday Cage of 42 x 40 x 44 cm



GIN Setup I

1. HV System
   - GEM alimentation box, 7 cables, GEM + 1st FC ring
   - 50kV cable for HV
   - DAQ system same as LNGS

2. Gas Line
   - He and CF4 gas bottle
   - Flux Control
   - General sensor Temperature, Pessure, Room Humidity
   - Densimeter
   - Two Gas Humidity sensors before and after GIN



GIN Setup II

Graphana for monitoring sensors, both real time and history

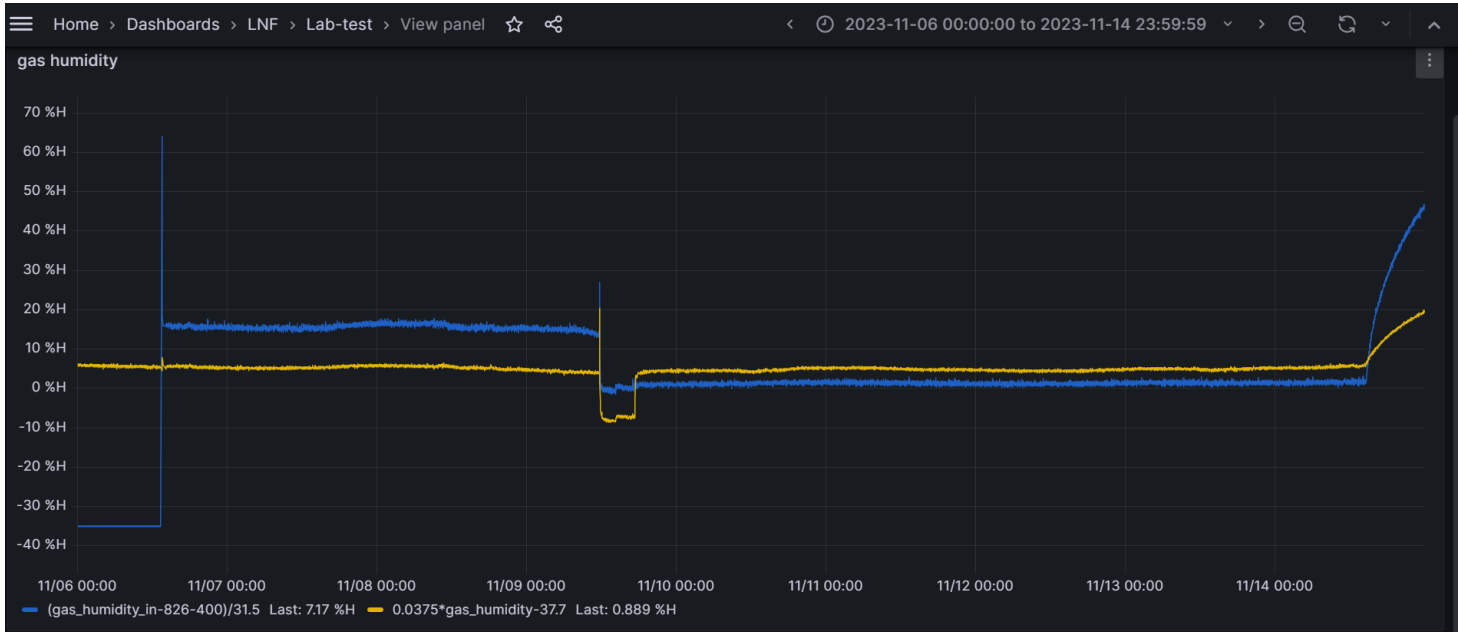
Room Temperature

Gas Humidity

Gas Density

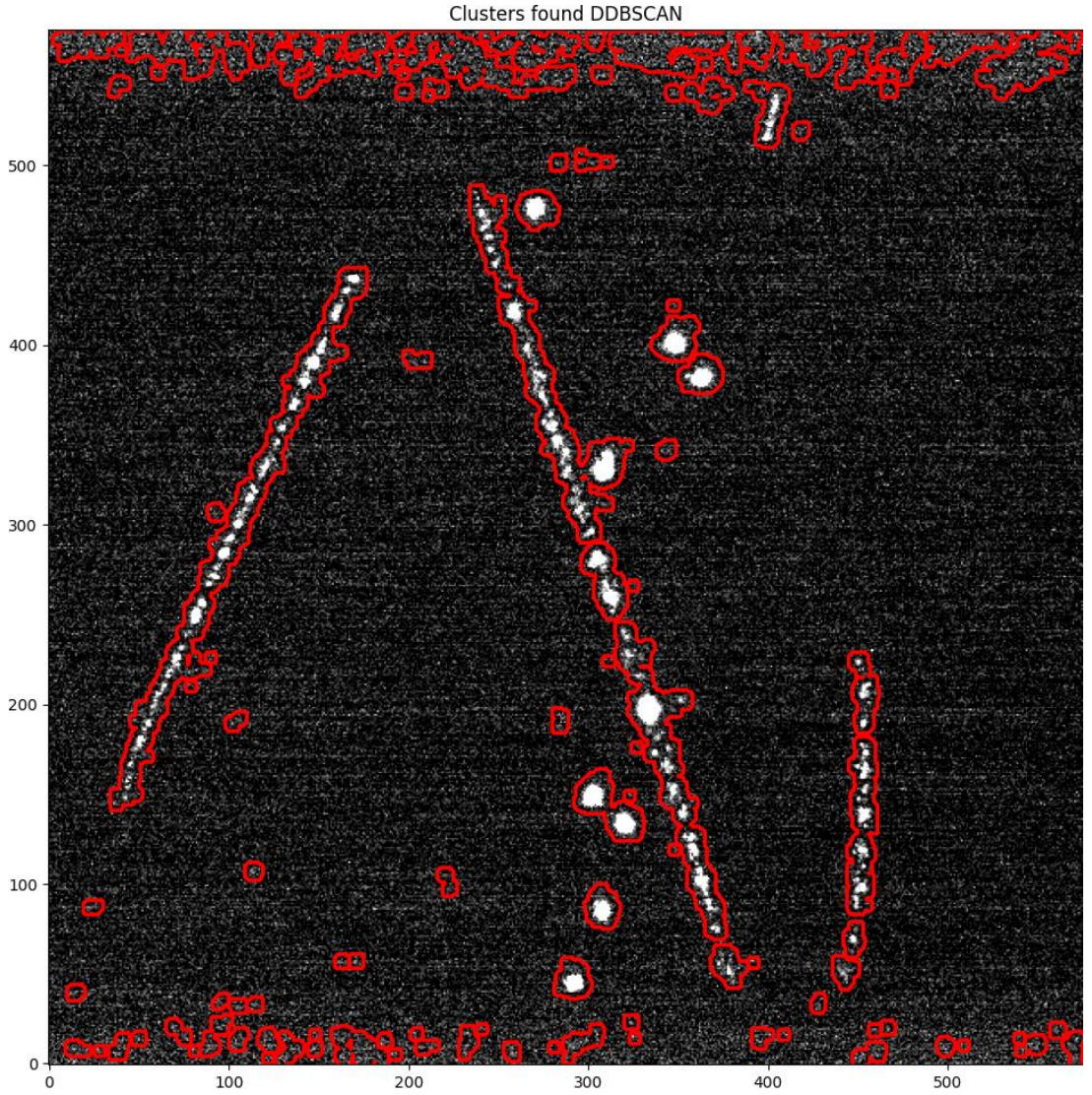
GIN Setup III

- Yellow line (after GIN) gas humidity sensor is same model as LNGS
- Blue line (before GIN) sensor is different and added later
- Calibration with pure Nitrogen
- Blue is now calibrated
- Yellow left uncalibrated for matching LNGS measures, its 0% is around real 5%



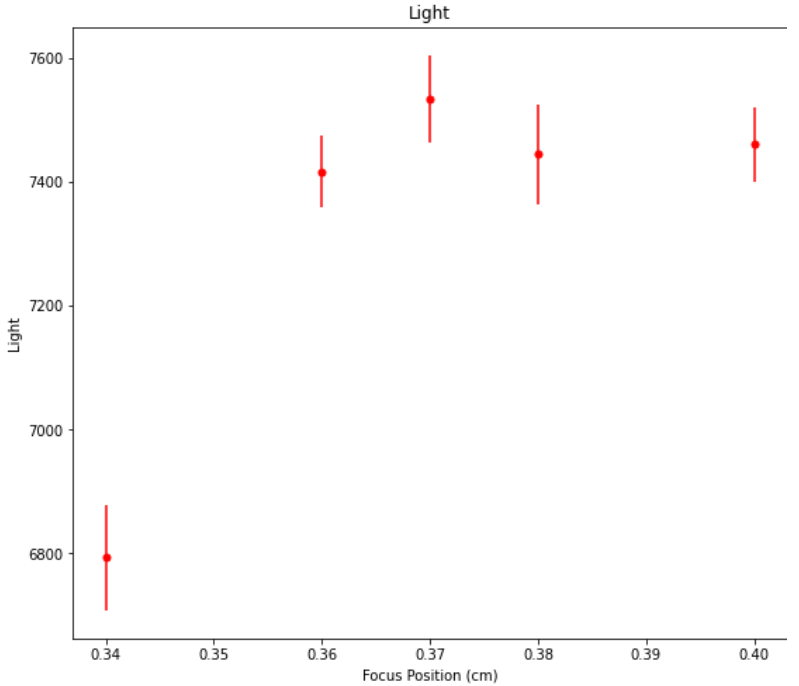
GIN Camera's Position

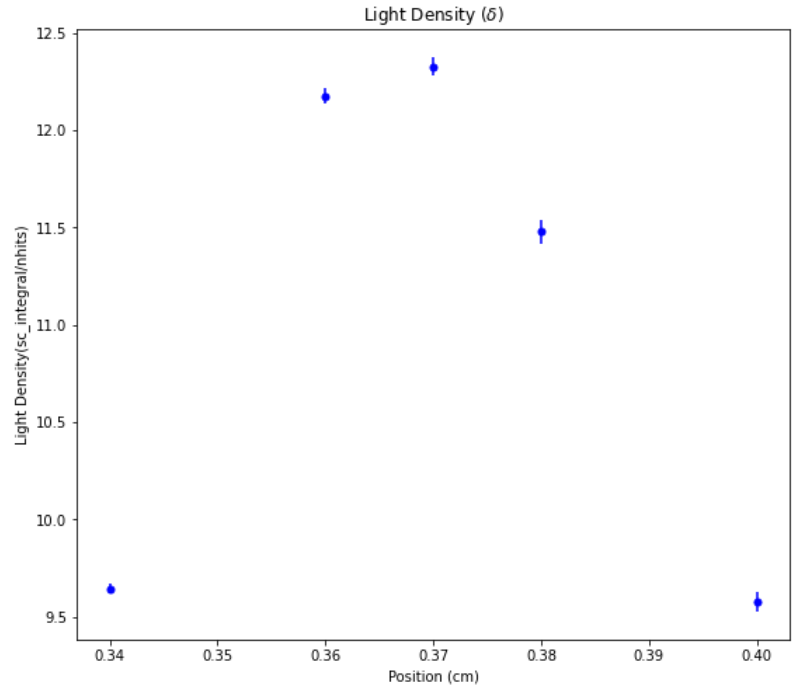
- Position such that noisy bands up and down are excluded from GEM's visible
- Knowing the GEMs dimensions and the effective pixel of our sensor it was possible to calculate sensor's granularity (50µm x 50µm)
- Also possible to calculate Geometric Acceptance (9.2 e-4)



GIN Camera's Focus

- Camera position fixed
- Data scan for focus position
- From analysis is clear that the best position for focus is 0.37cm



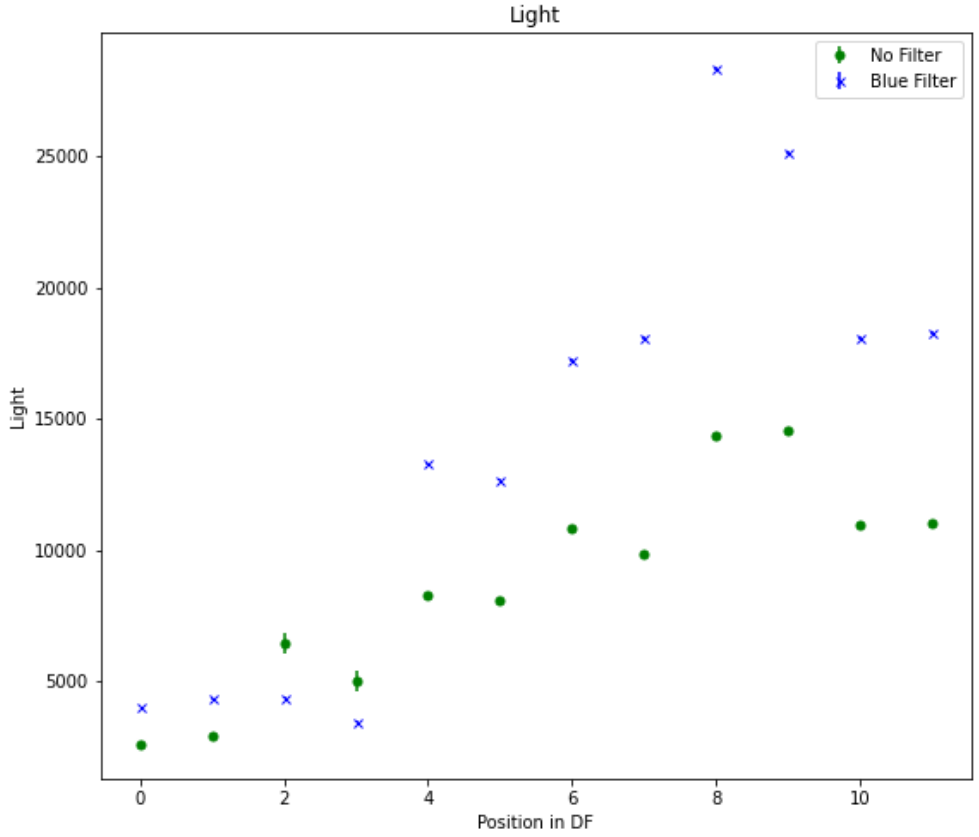


Humidity Issues I

- Data analysis gave for Fe55 source an sc_integral around 7500
- MANGO at LNGS overground has very similar features to GIN (GEM at 420V for MANGO have the same gain of GEM at 440V for GIN and Geometric Acceptance differ by a 10%)
- MANGO sc_integral for Fe55 source is around 30000-33000
- Humidity in GIN is aroud 27%, probable humidity issue!
- Leakage of the box discovered, but not great improvement

Humidity Issues II

- Water filter (Blue filter) and the second humidity sensor were added
- Humidity is 0% before GIN, but 15% after GIN, sc_integral around 14500
- We increased the flux from 4,5 l/h to 9 l/h. Little overpressure, humidity dropped to 5% after GIN
- sc_integral at VGEM 440V around 20700



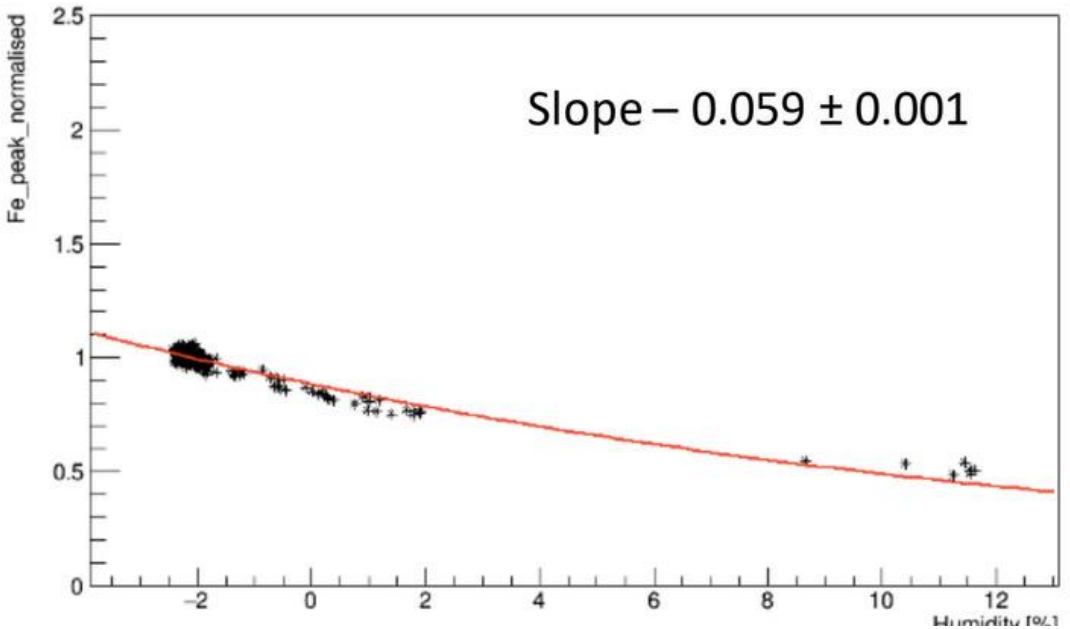
	position point	Vgem (V)	Drift Field (kV)
0	3.0	410.0	0.5
1	3.0	410.0	1.0
2	7.0	410.0	1.0
3	7.0	410.0	0.5
4	3.0	440.0	0.5
5	3.0	440.0	1.0
6	7.0	440.0	1.0
7	7.0	440.0	0.5
8	7.0	450.0	0.5
9	7.0	450.0	1.0
10	3.0	450.0	1.0
11	3.0	450.0	0.5

Humidity Issues III

$$light = e^{A+HB}$$ H = Humidity

- Rita Antonietti correlated light yeld of LIME sensor (same as GIN) with humidity through an exponential formula
- We superimposed our data to her plot
- Extrapolating the value with humidity -2% GIN has the same light yeld as MANGO
- We are happy with this light yeld

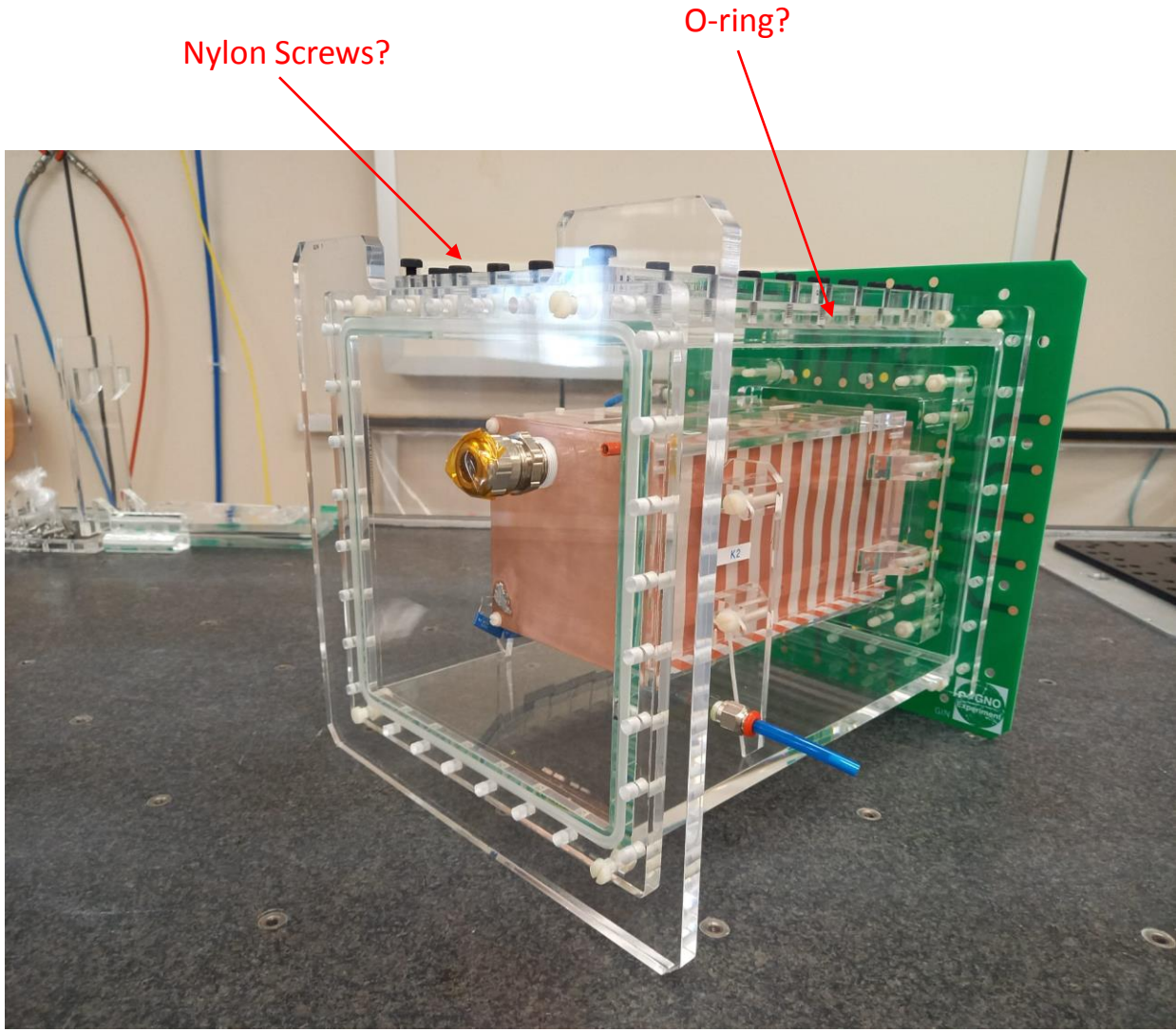
Rita's plot Light vs Humidity



H [%]	Expected ^{55}Fe Sc_integral count	GIN meas ^{55}Fe Sc_integral count
-2	29000-33000	N.A.
5	19000-21700	20700
15	10500-12000	14500
27	5200-5900	7500

Humidity Issues IV

- Where this humidity is coming from?
- While changing GIN Field Cage gas circuit was shortcircuited and humidity went to 0%
- There should be some loss in GIN, not in gas tubes
- Are nylon screws a problem?
- Or either O-ring?



Plan of Measures for FC Characterization

- Fixing Drift Field at 1 kV and scanning in position for VGEM in a range from 400V to 460V
- Fixing VGEM at 440V and scanning in position for Drift Field in a range from 0.2kV to 1.5 kV
- Same for VGEM at 400V
- Long Exposures for Muons at 440V VGEM
- Camera Exposure chosen to be 0.15 s for Short Exposures and 0.5 s for Long Exposures

Possible Analysis:

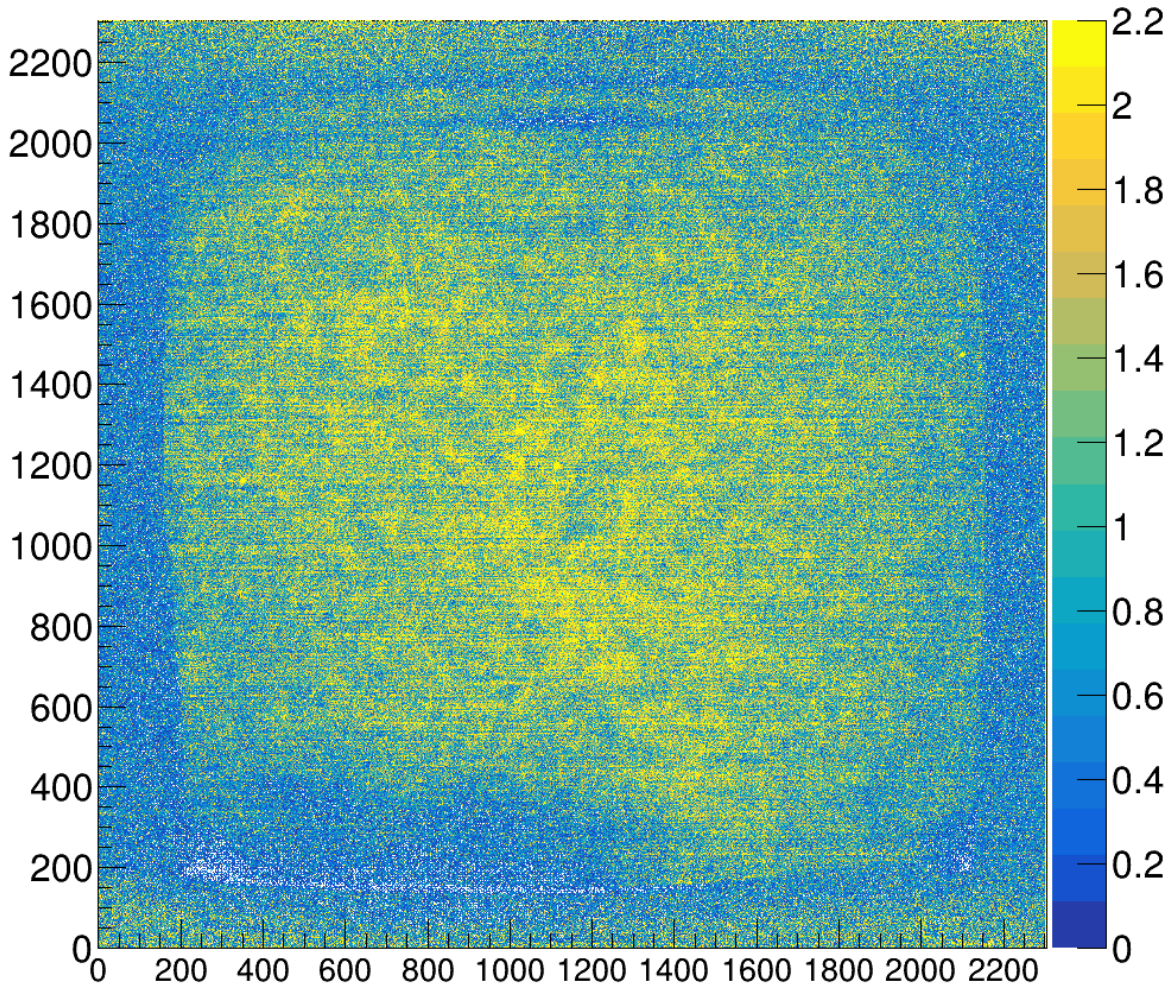
- Gain scan at different position
- Drift scans at different fields and position
- Using Muons long exposure for Field Uniformity

PMTs Data

- GIN has two PMTs on its diagonal
- PMTs are used as Trigger and their signal is saved
- Scan for PMTs Rate, found a Plateau for Fe55
- We fixed number of counts to 1670 ± 40 and changed the threshold each Drift Field or VGEM change
- For low values of VGEM was not possible to reach that number and we fixed the threshold to 3mV
- Further analysis on PMTs signals

Long Exposure Results I

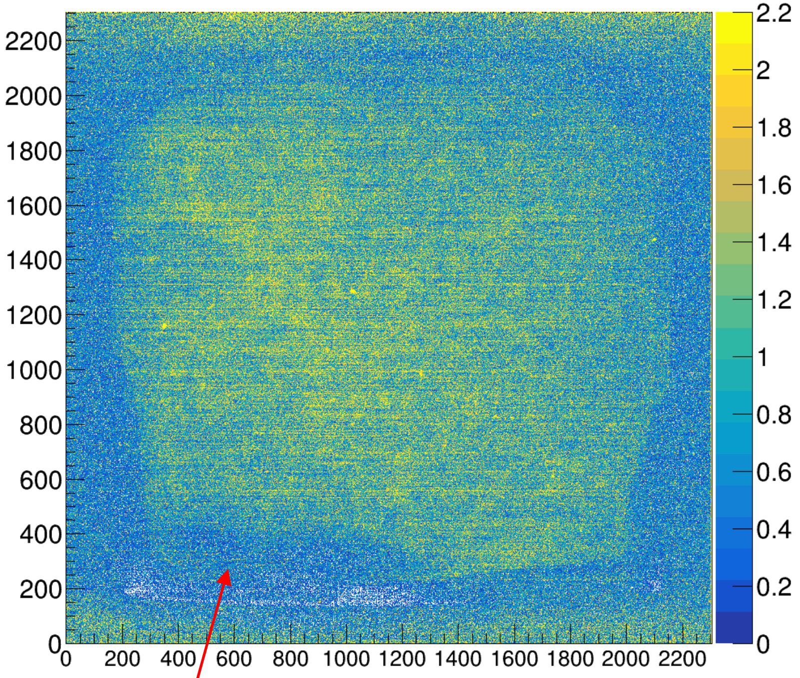
- Fe55 Source was removed
- VGEM is fixed to 440V
- Freerunnig, not triggering on PMTs
- Scanning on Drift Field
- Camera Exposure 0.5s instead of 0.15s
- Field not uniform near corners and bottom borders. Unknown problem in left-bottom corner

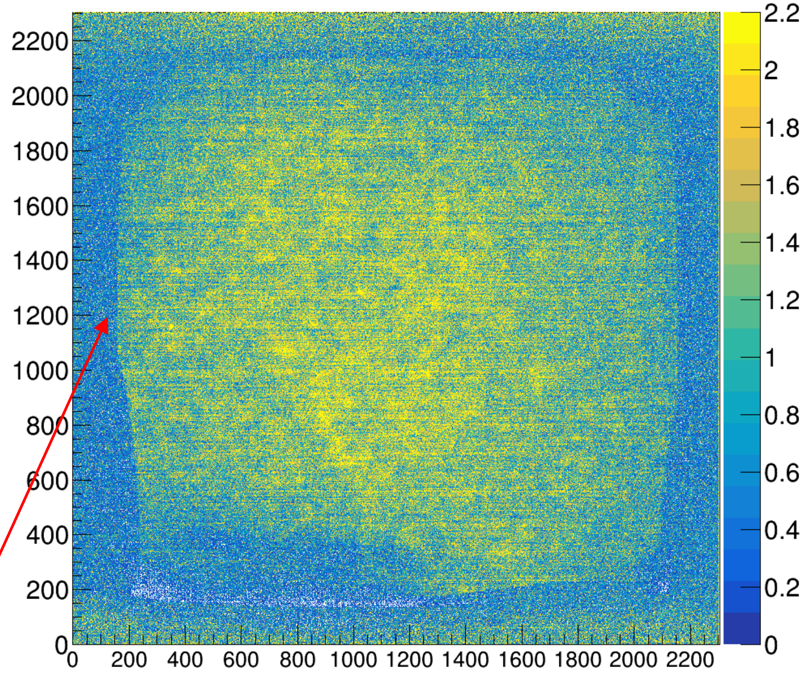


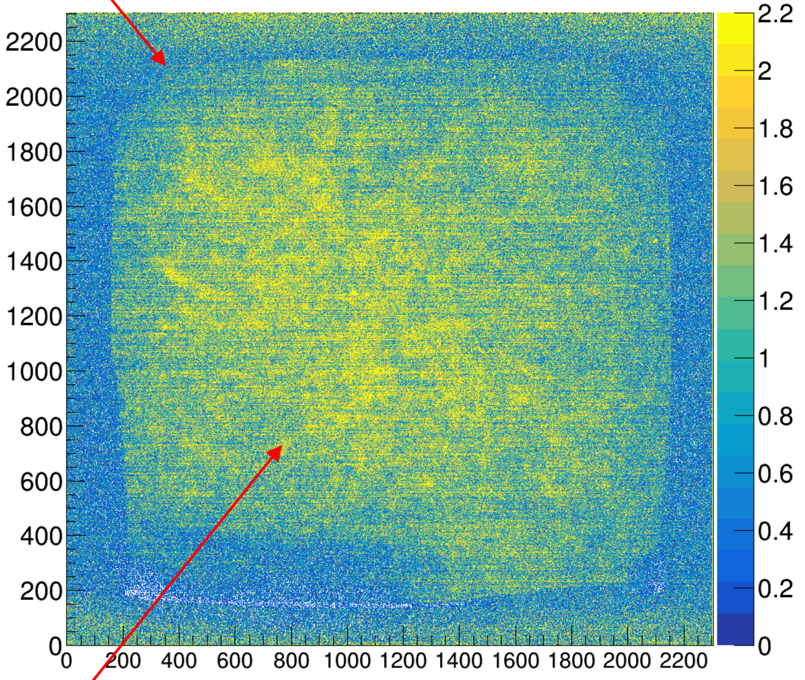
Long Exposure at 1.5kV

Long Exposure Results II

Corners more defined, but FC is rounded







Borders more defined

Field uniform also in the lower part

Long Exposure at 0.2kV

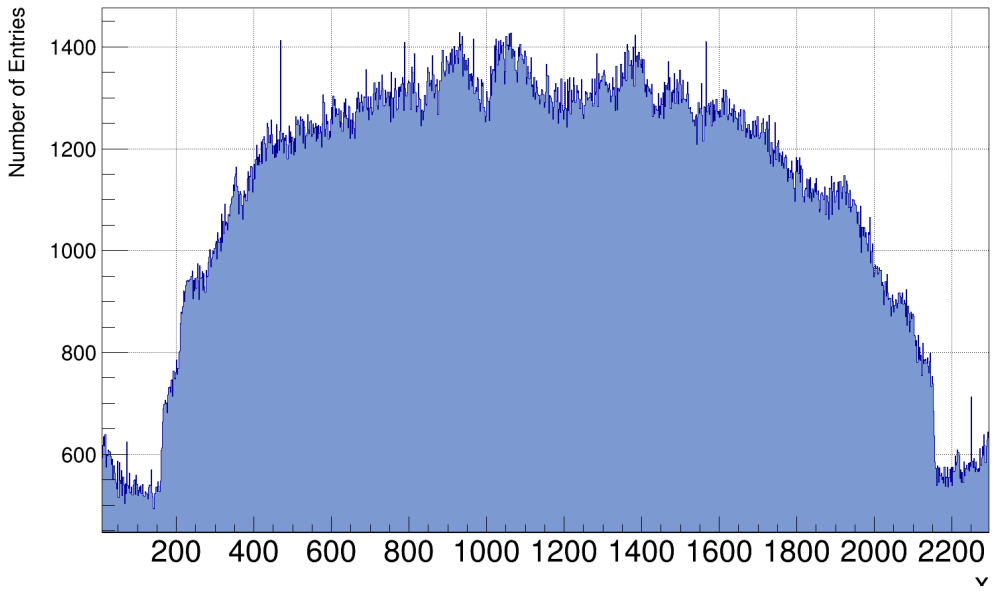
Long Exposure at 0.6kV

Long Exposure at 1kV

Problem with Field here ?

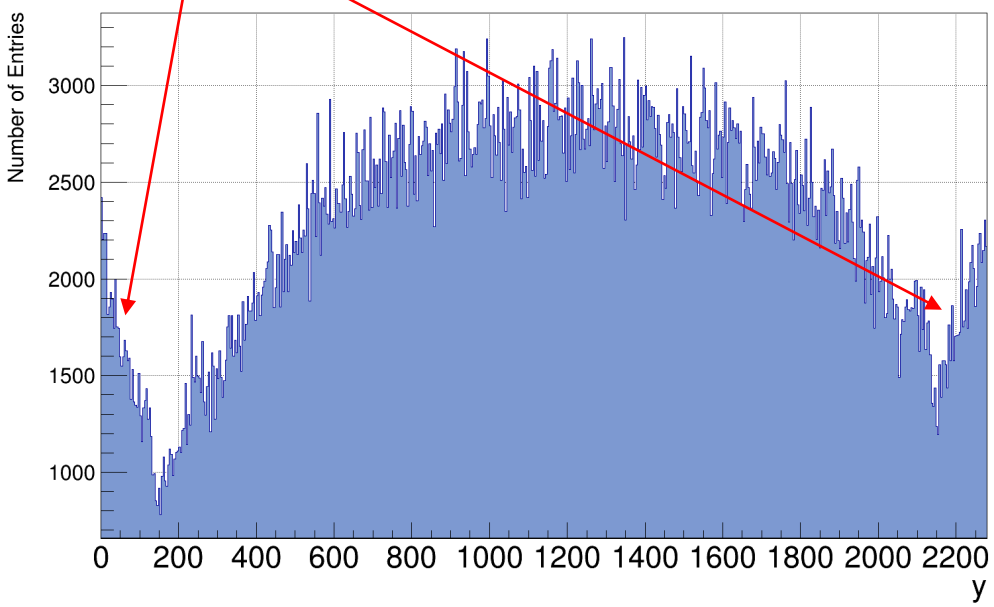
Long Exposure Results III

Horiziontal Projection 1kV

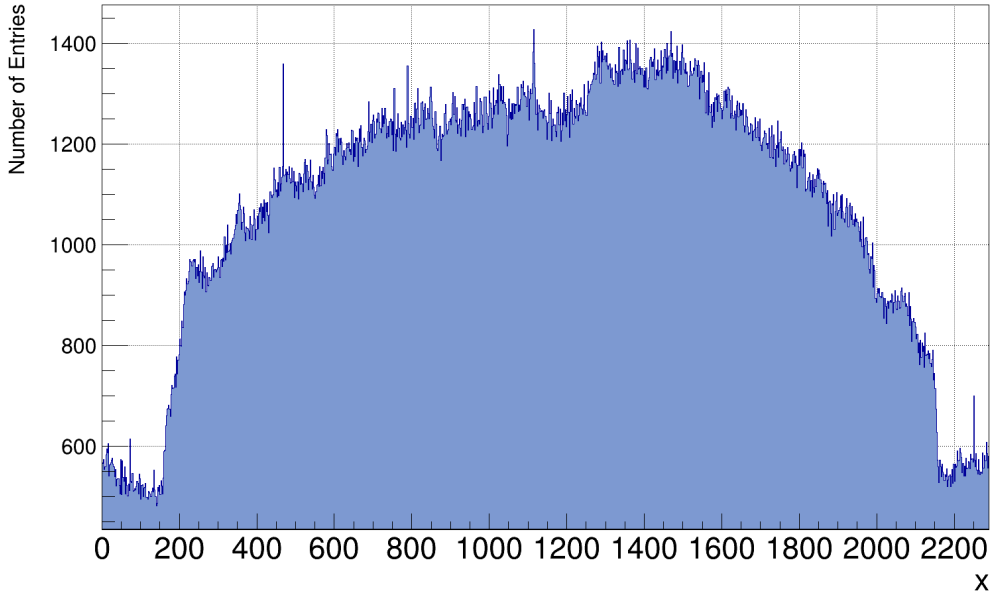


Noisy Bands

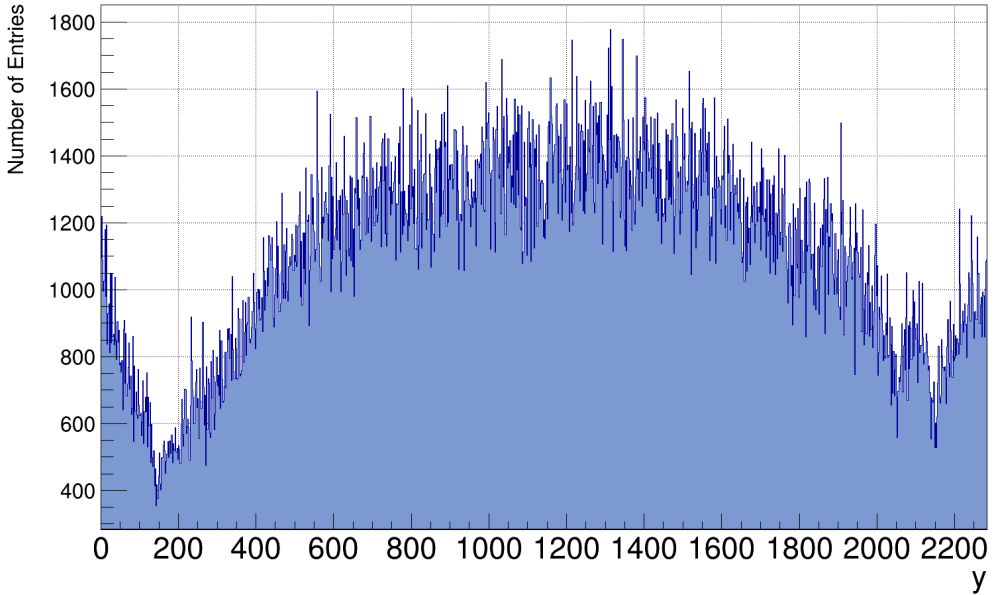
Vertical Projection 1kV



Horiziontal Projection 1.5 kV

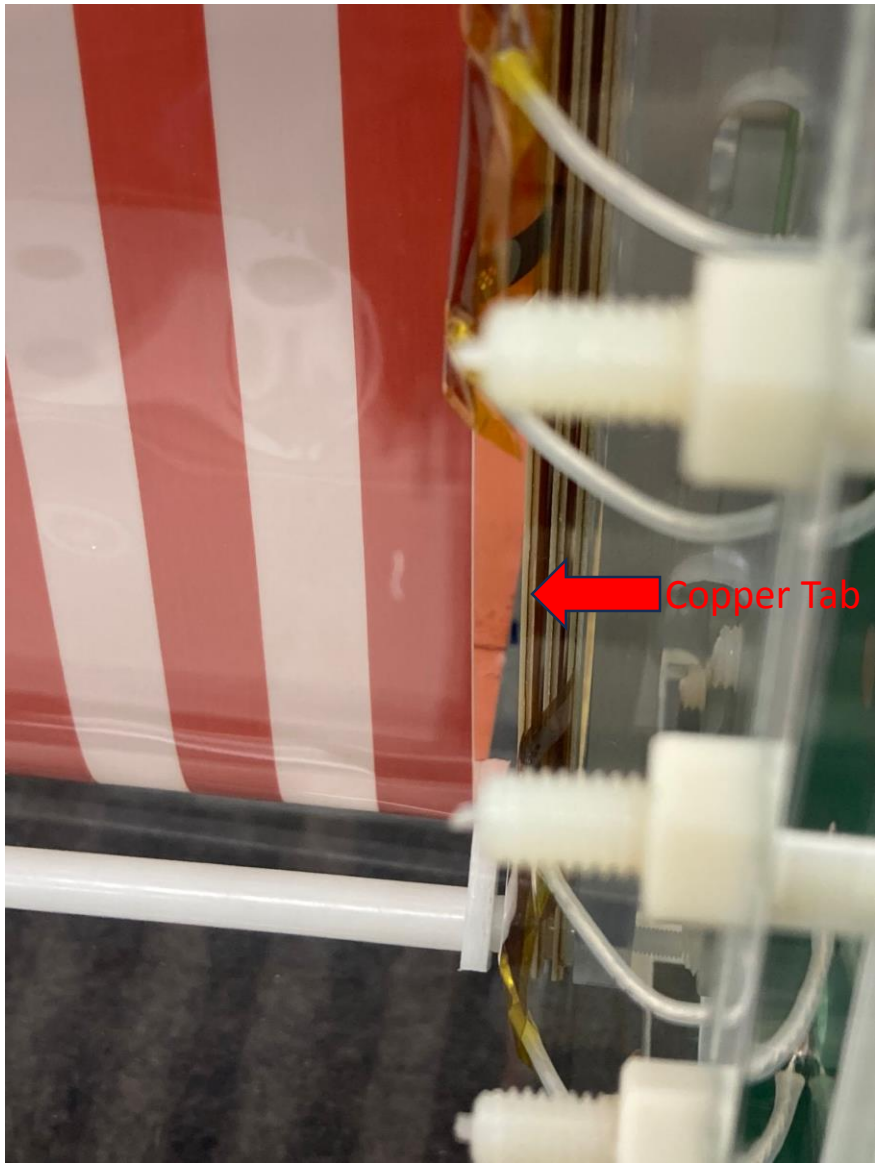


Vertical Projection 1.5 kV

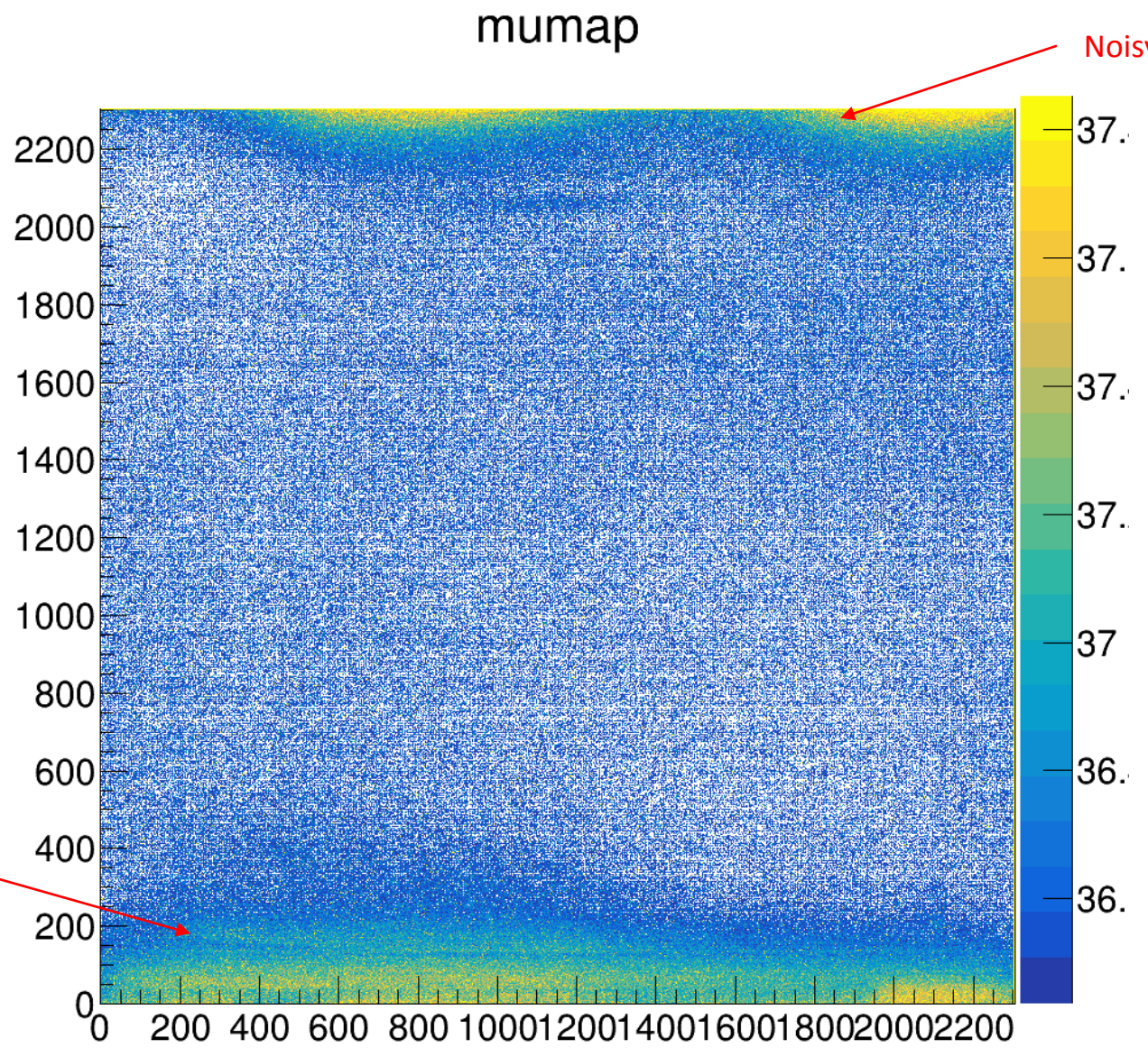


Long Exposure Results IV

- No field in the bottom-left corner
- Field is not closing properly?
- Could be related to a Copper Tab used to fix the Field Cage?
- Probable test with other materials

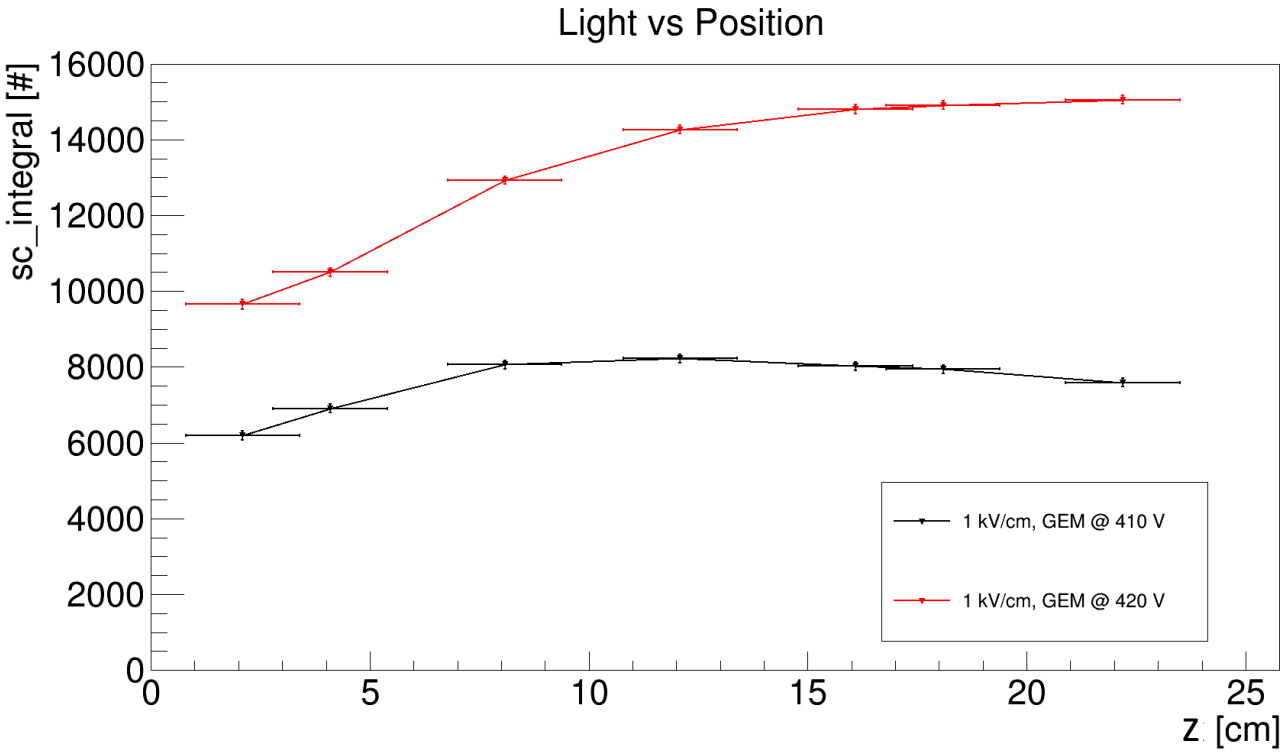


Long Exposure Results V



Short Exposure Results

- Light has been obteined with a Gaussian fit on Iron spots
- Saturation starts earlier at higher VGEM as expected
- Error in position is evaluated with a Gaussian fit on x-y spread of Iron spots, supposing spread on z is same as x-y
- Error on z has been reduced considering just spots in the higher part of detector (less spread)

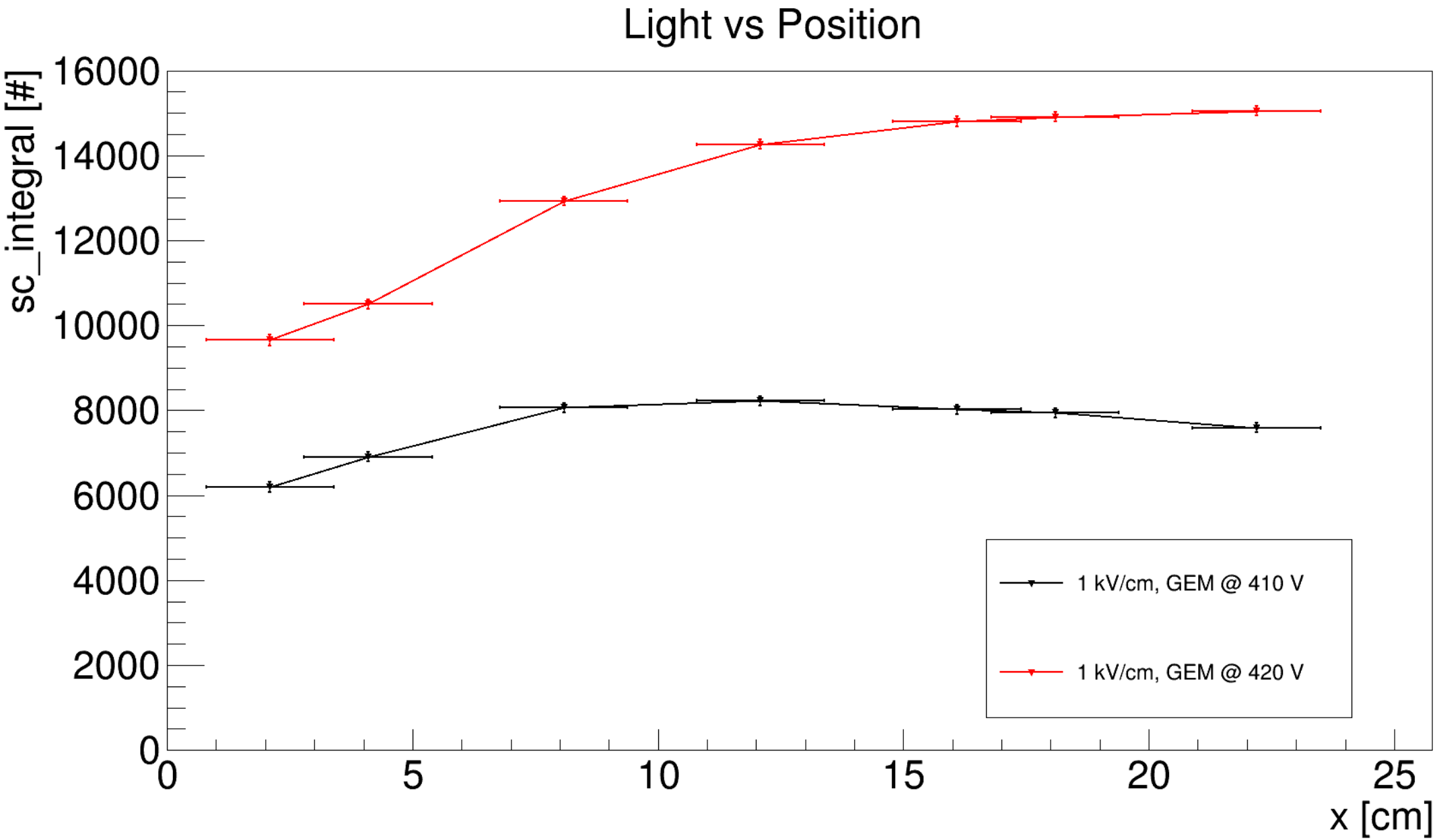


Conclusion

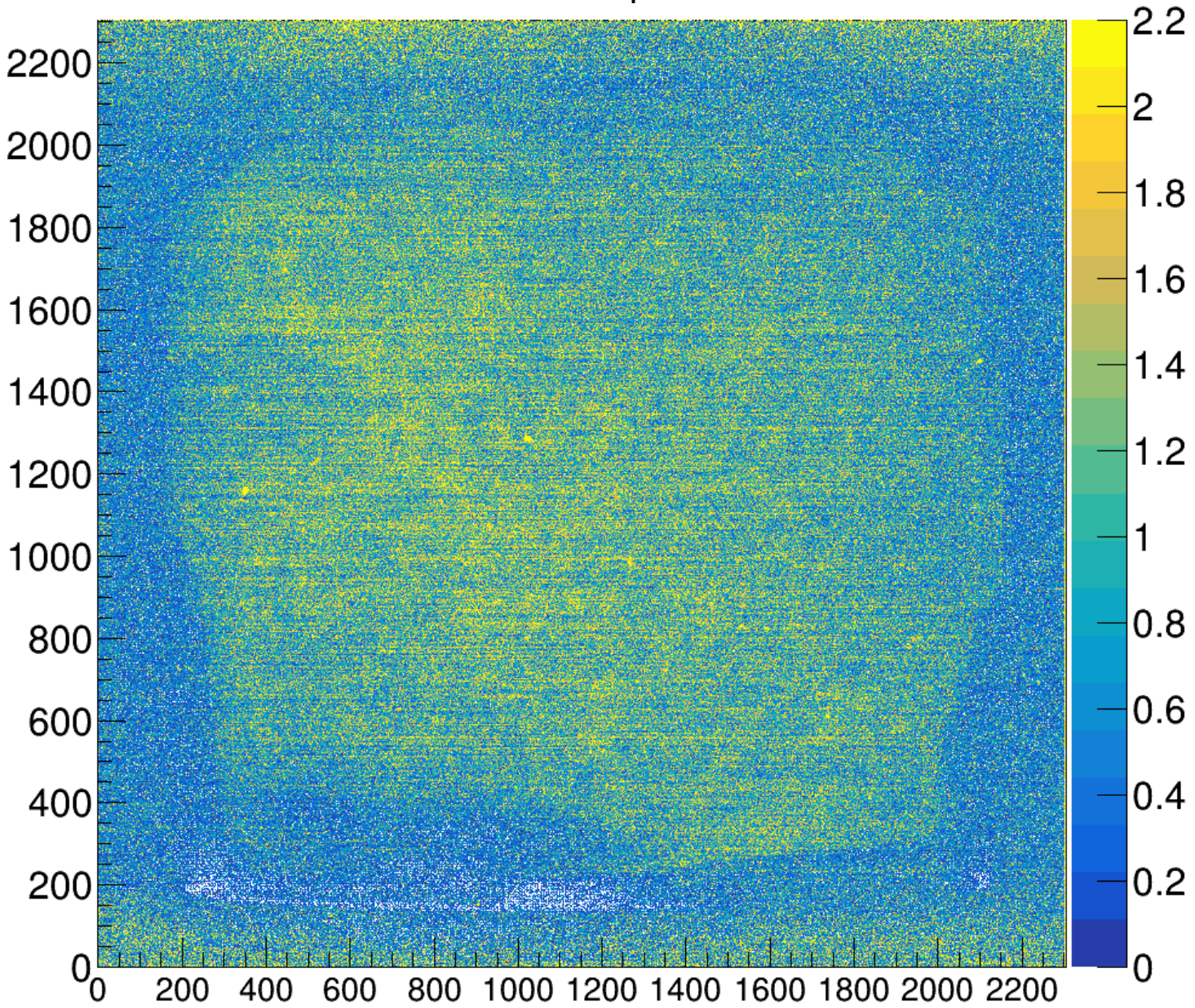
- GIN setup ready with environmental and gas sensors and updated DAQ
- Trials to find GIN’s loss and fix humidity issues for higher light yeld
- Test about Uniformity of Drift Field and ongoing analysis to characterize *Flying* FC
- Analysis on PMTs signals
- Change of GIN FC almost completed and soon to be characterized

THANK YOU!

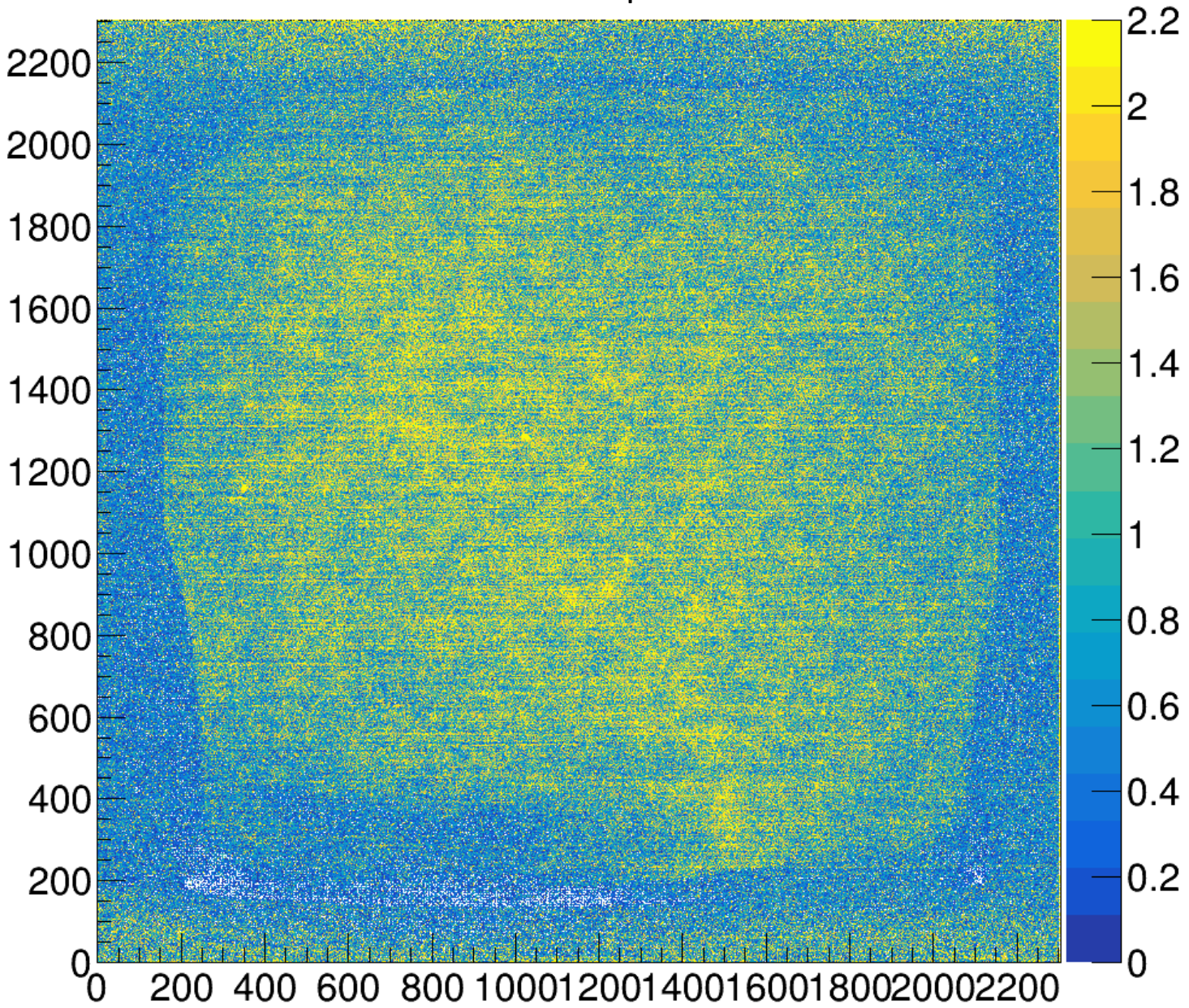
Backup


Light vs Position
sc_integral [#]
16000
14000
12000
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
x [cm]
1 kV/cm, GEM @ 410 V
1 kV/cm, GEM @ 420 V

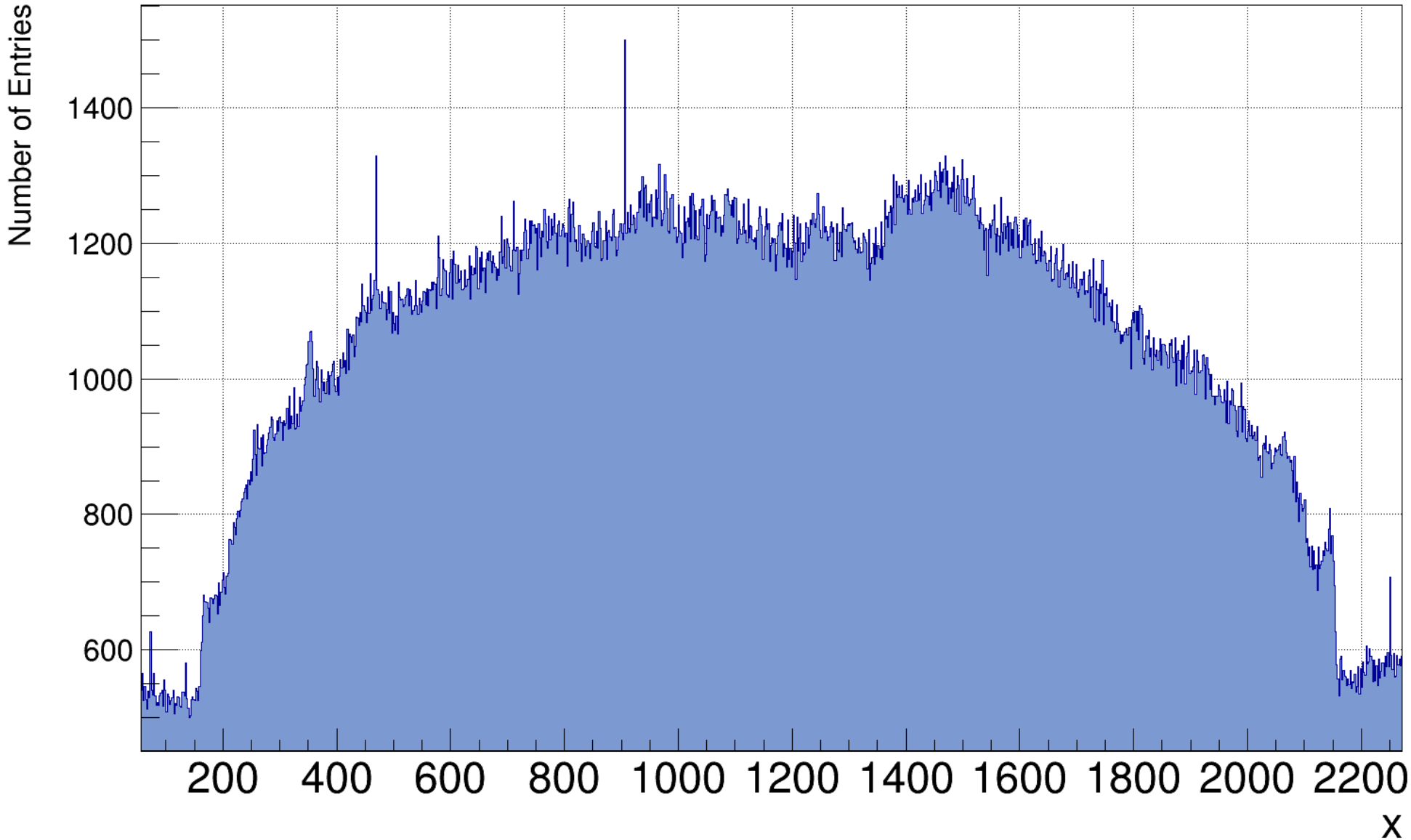
Muons map 0.2 kV



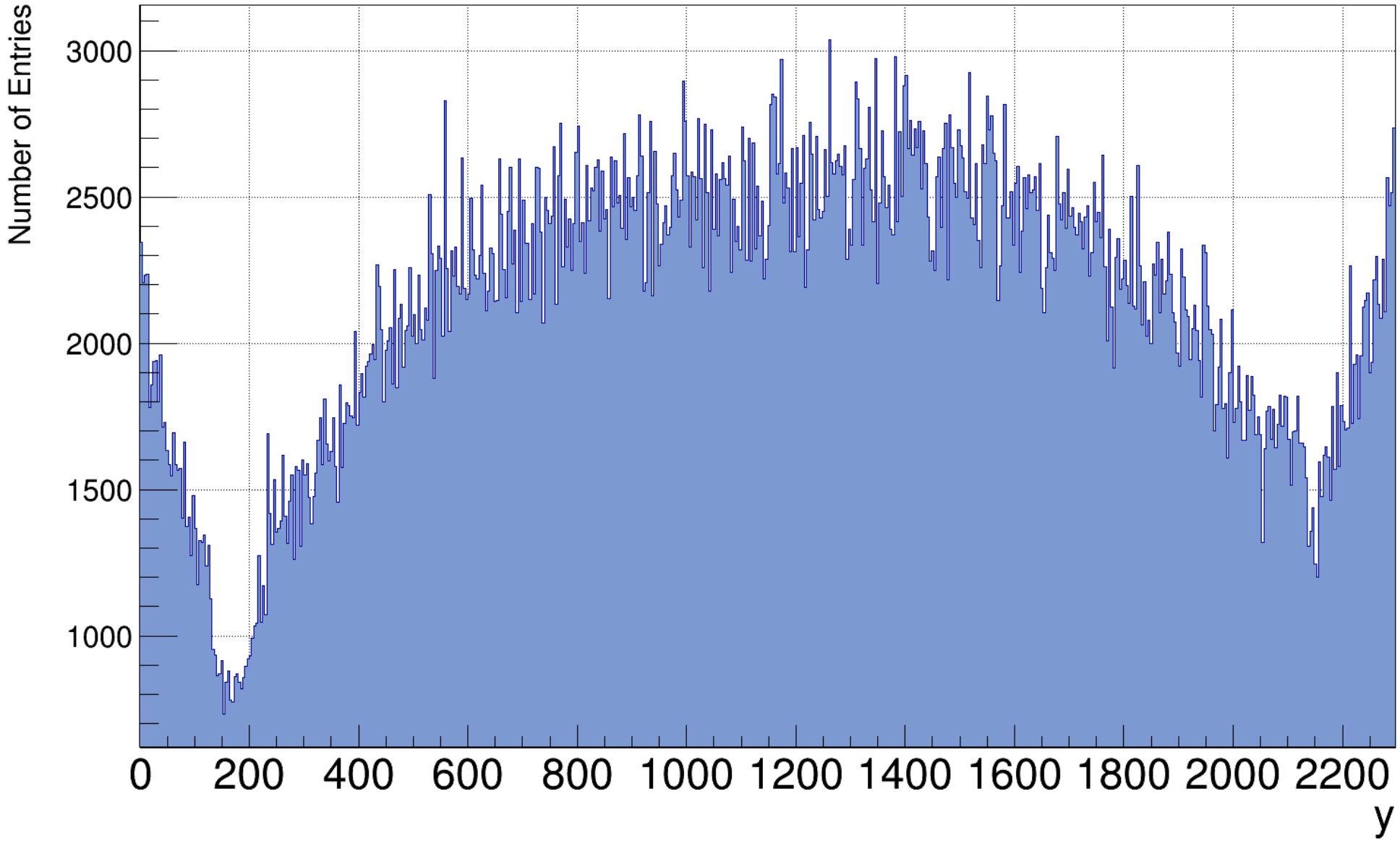
Muons map 0.4 kV



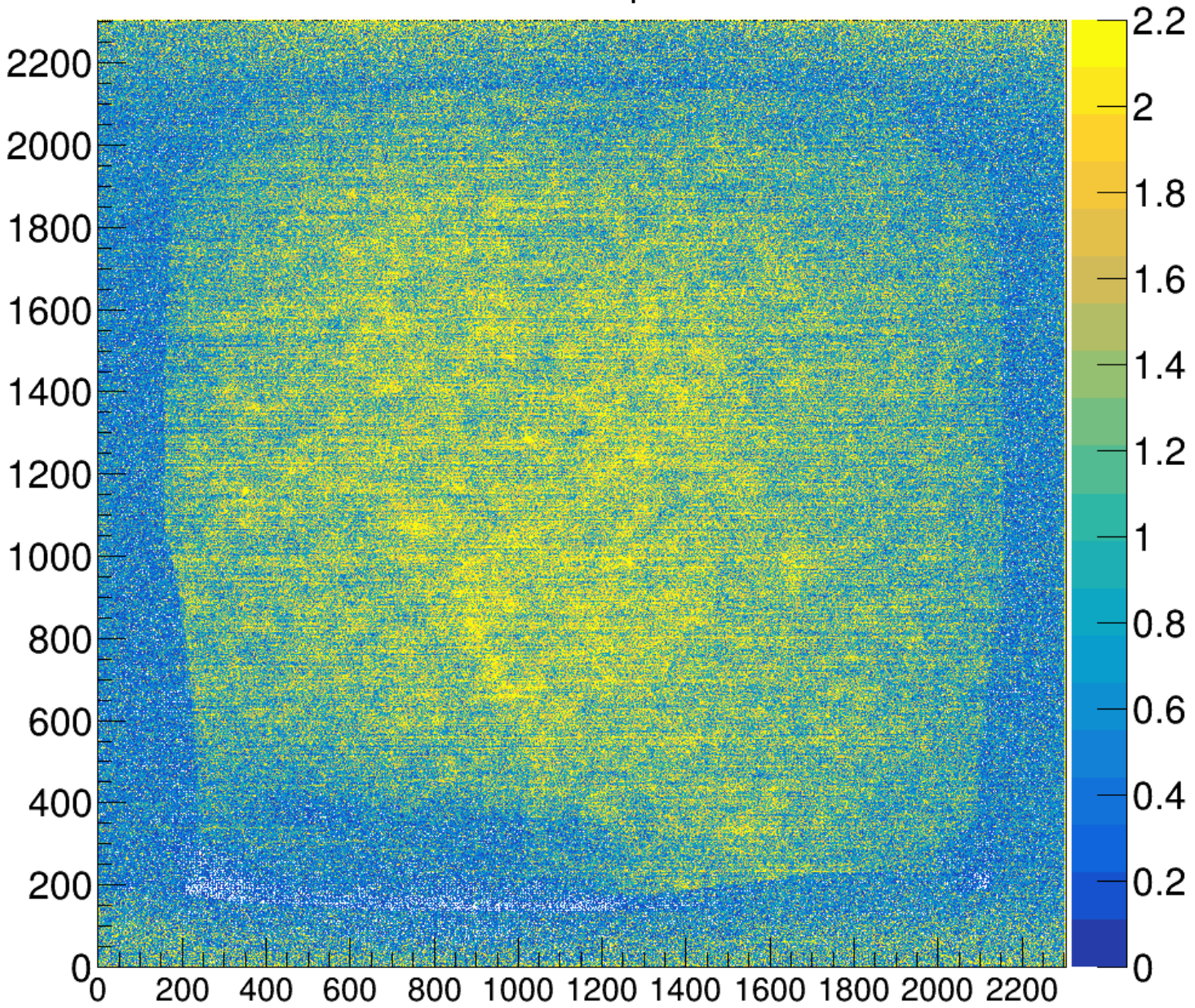
Muons horizontal projection 0.4 kV



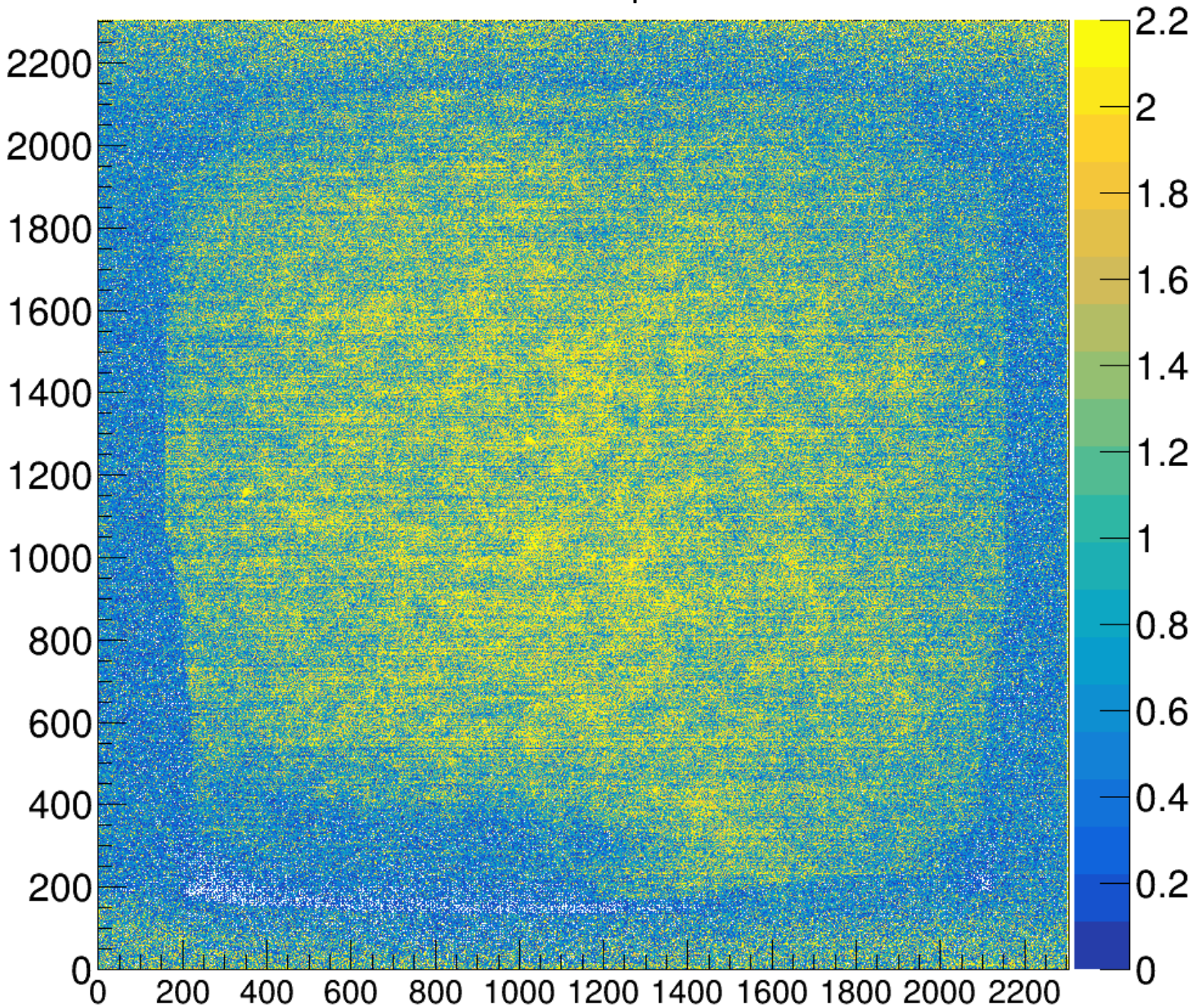
Muons vertical projection 0.4 kV



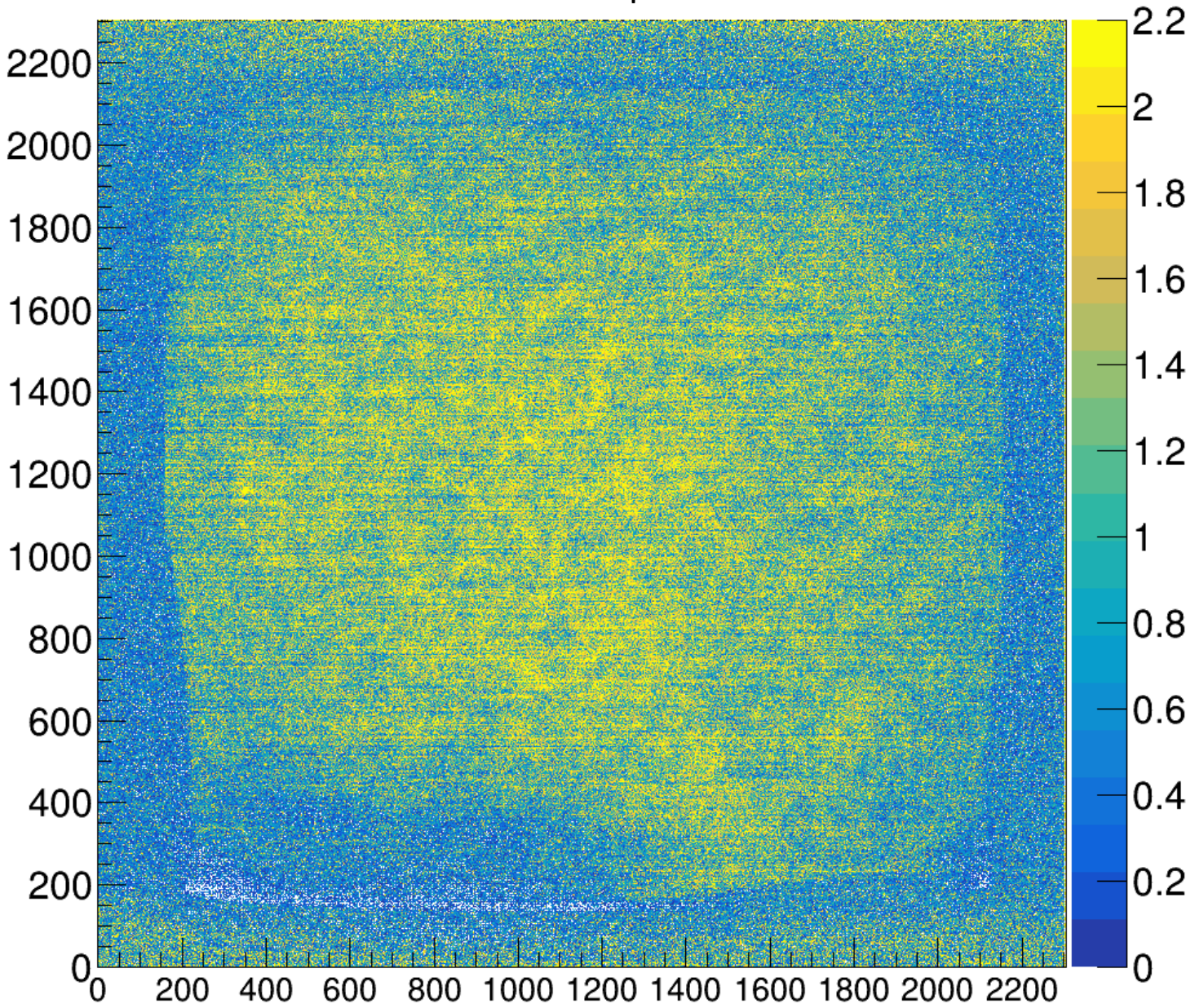
Muons map 0.6 kV



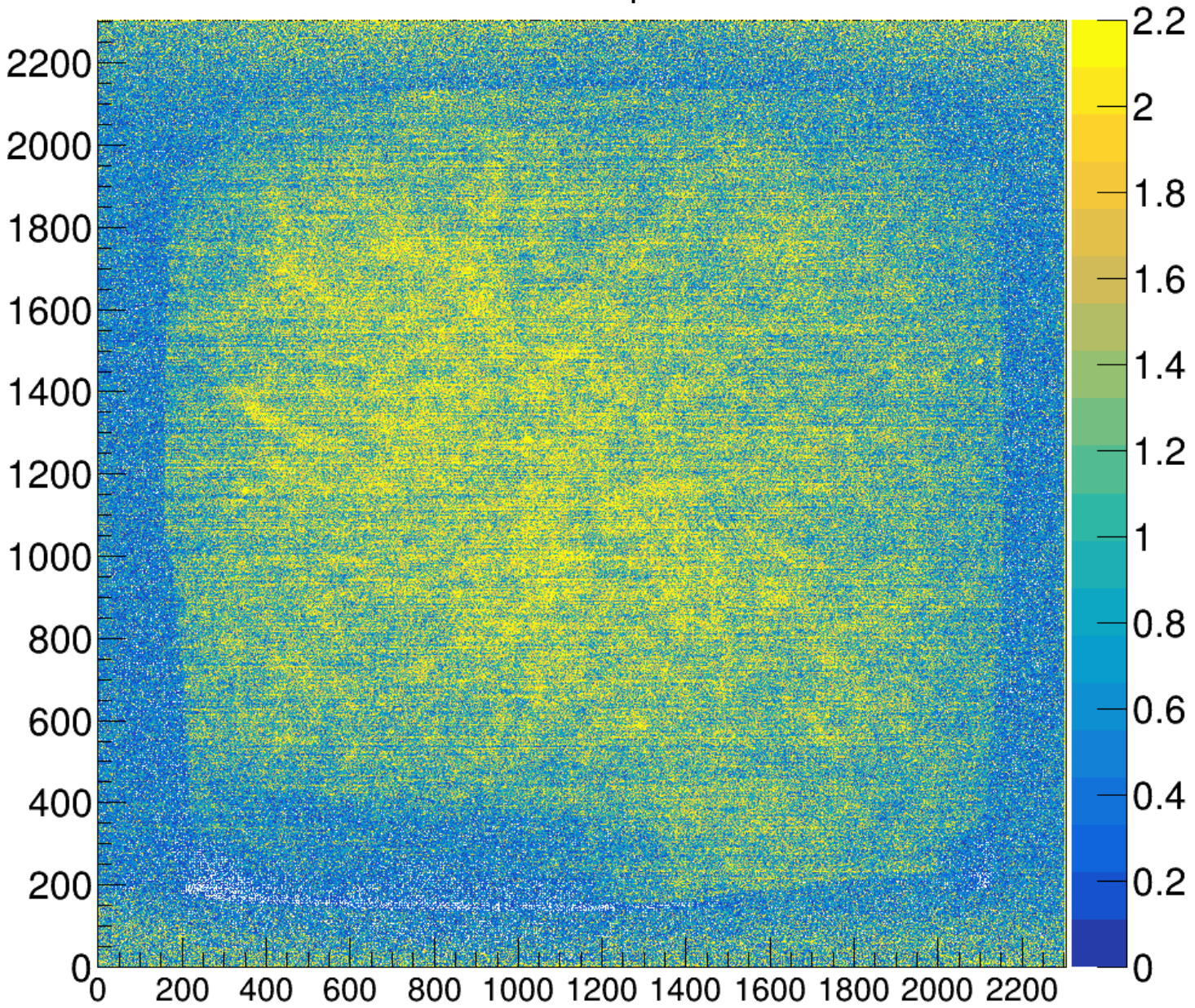
Muons map 0.7 kV



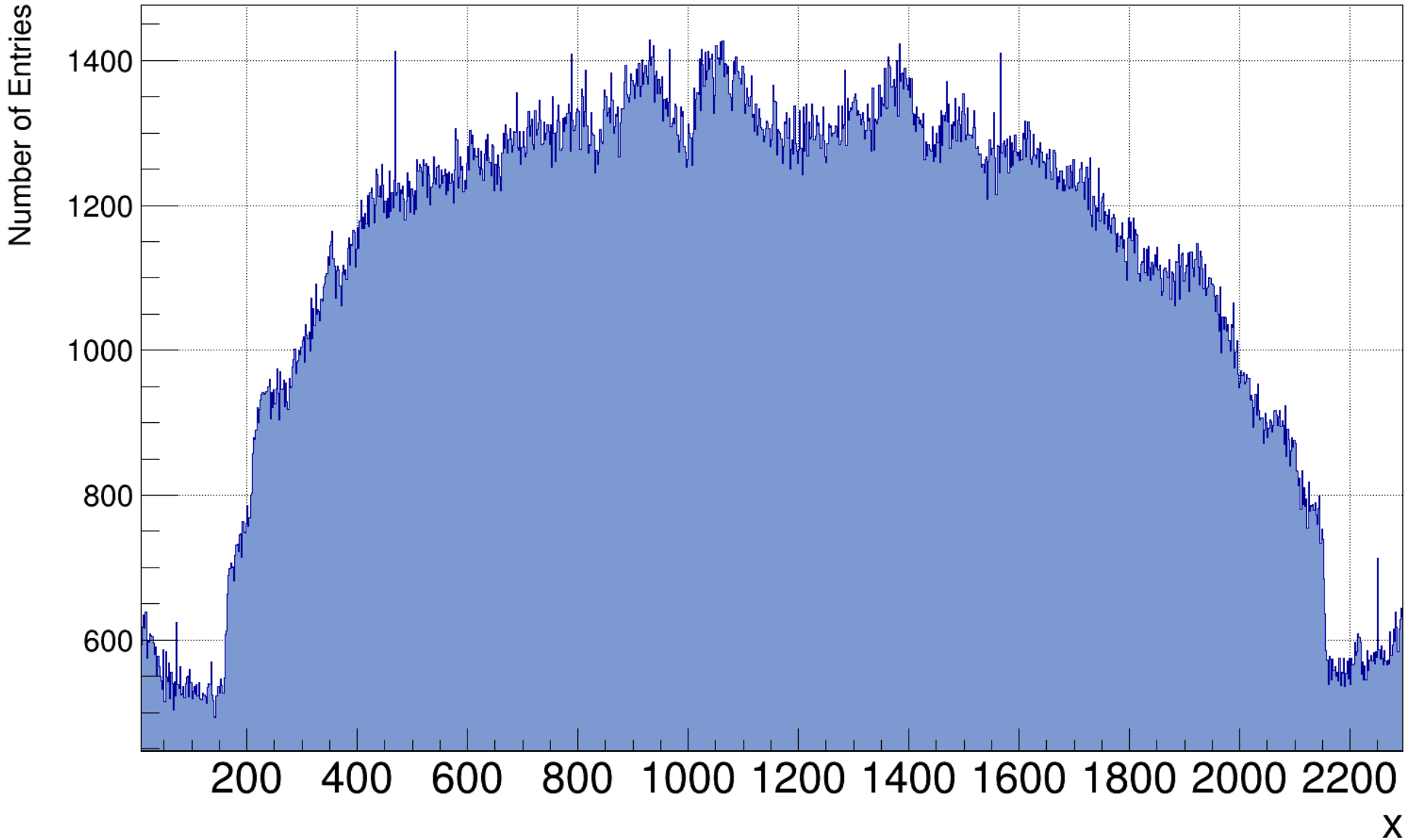
Muons map 0.8 kV



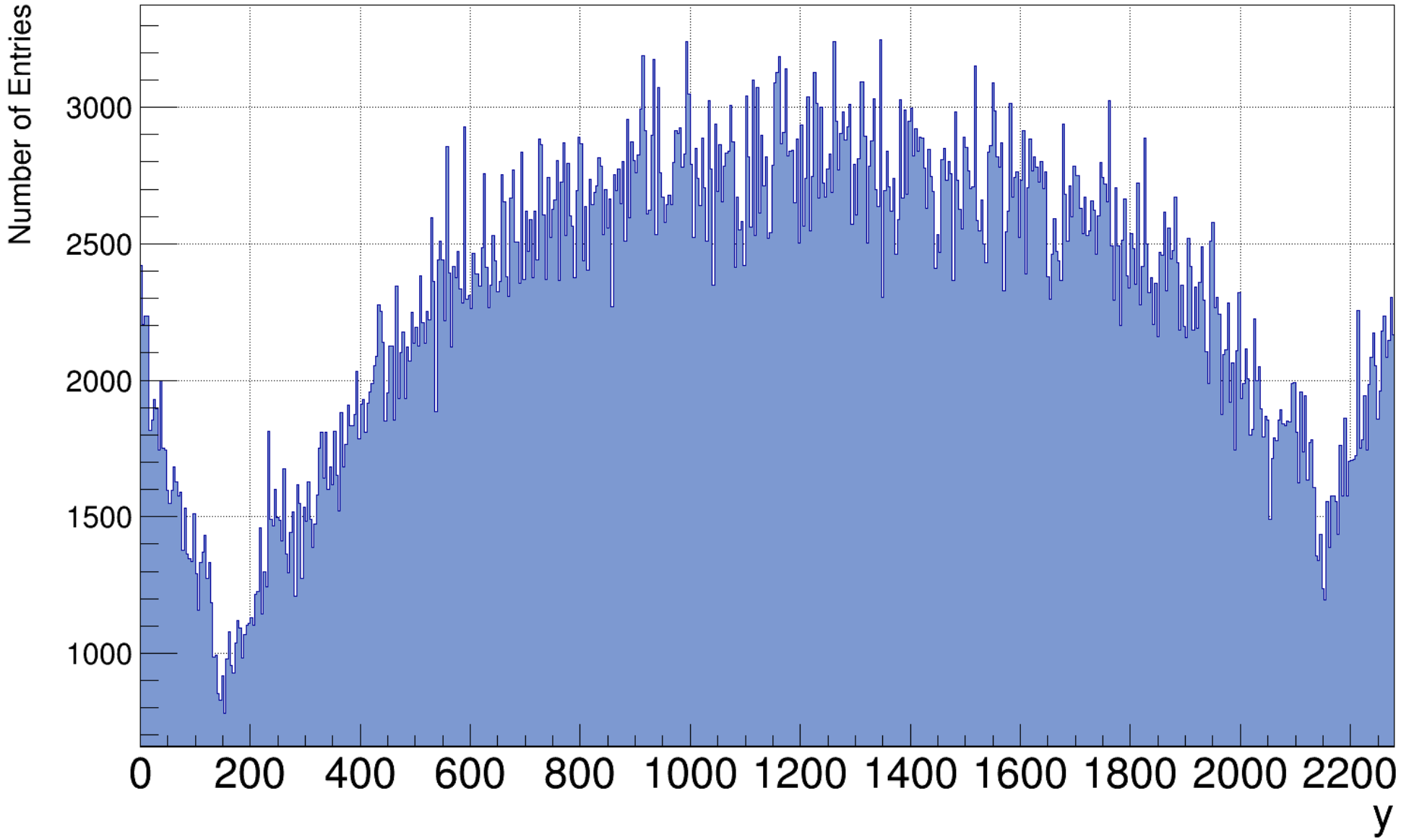
Muons map 1 kV



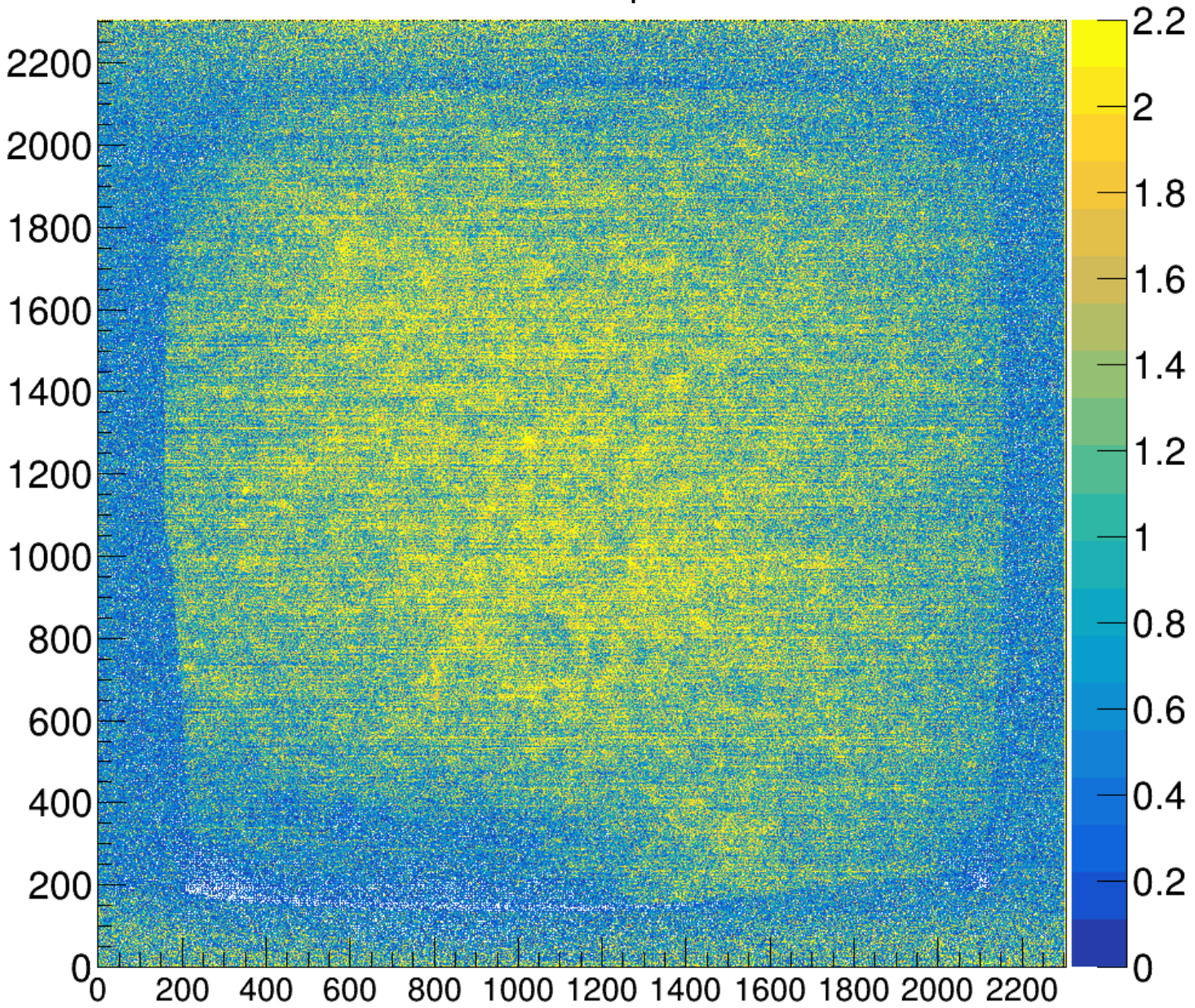
Muons horizontal projection 1 kV



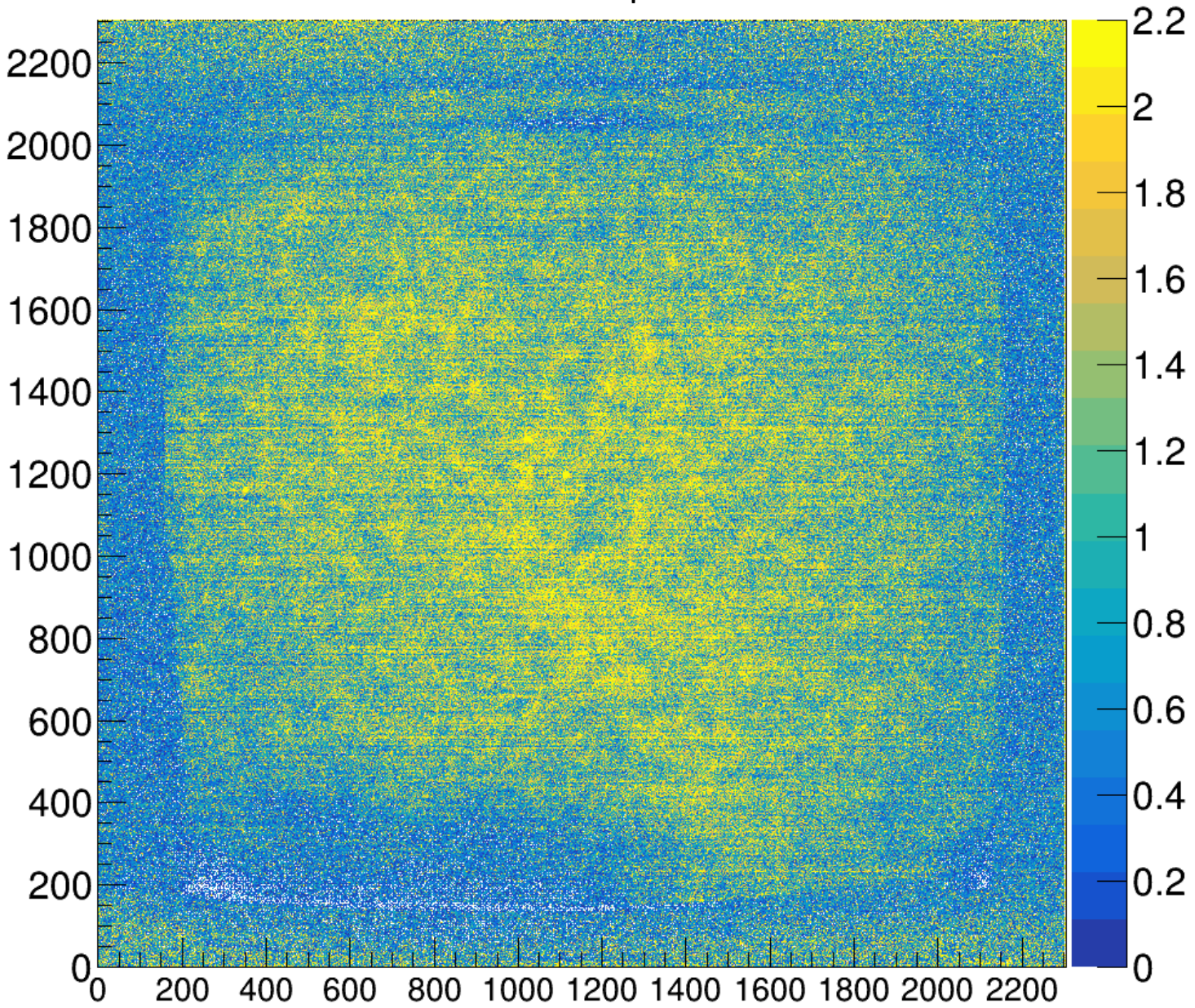
Muons vertical projection 1 kV



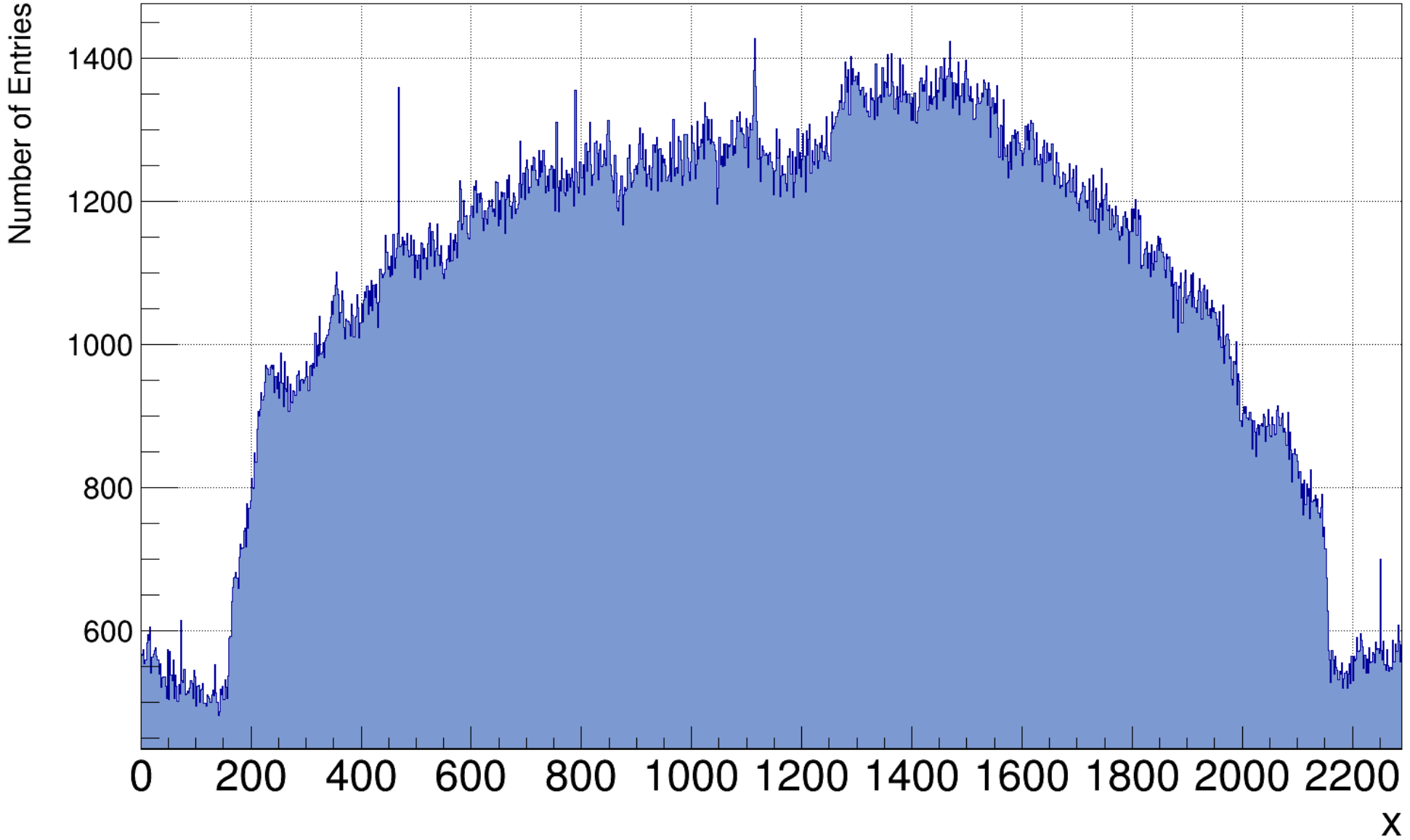
Muons map 1.2 kV



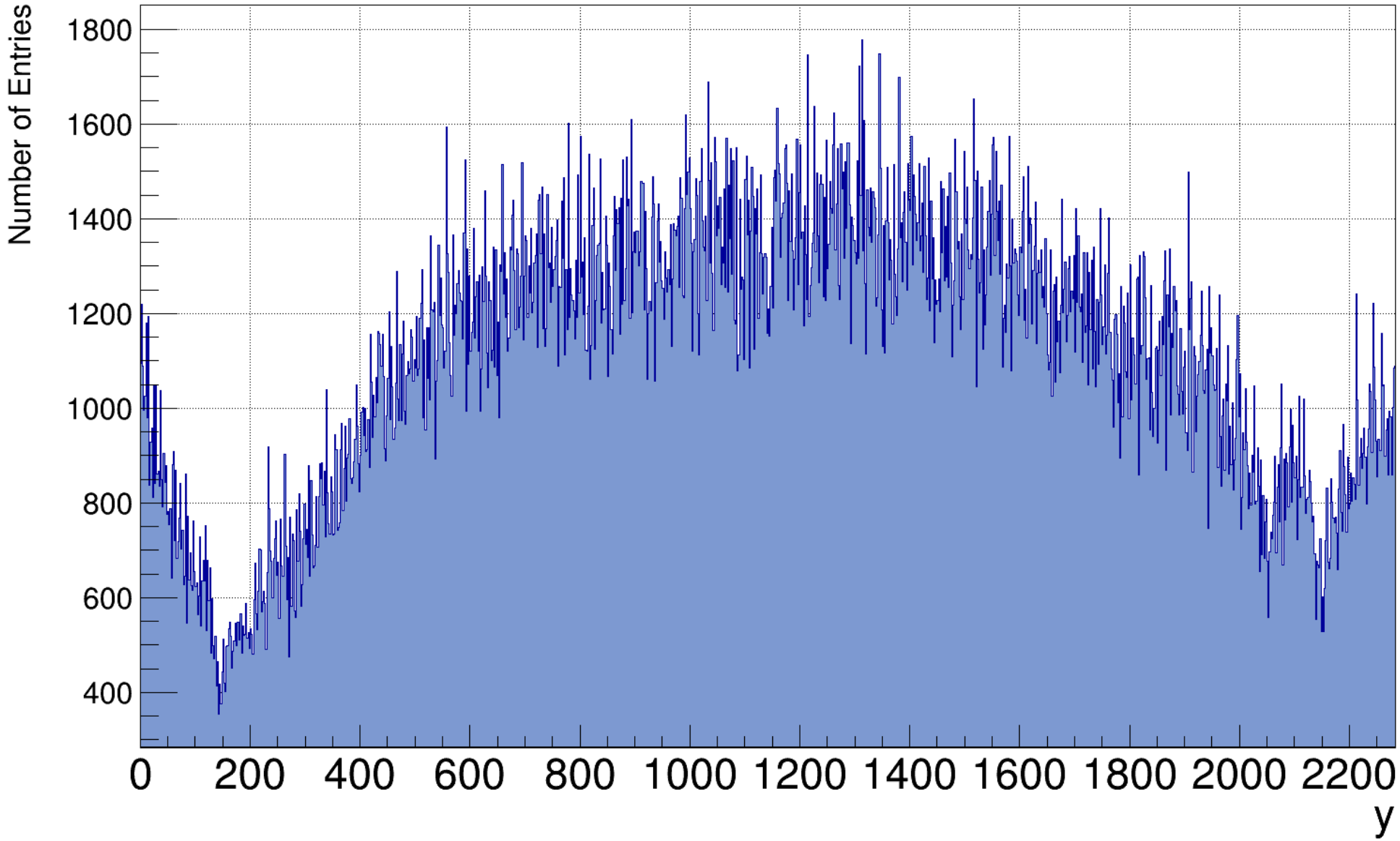
Muons map 1.5 kV



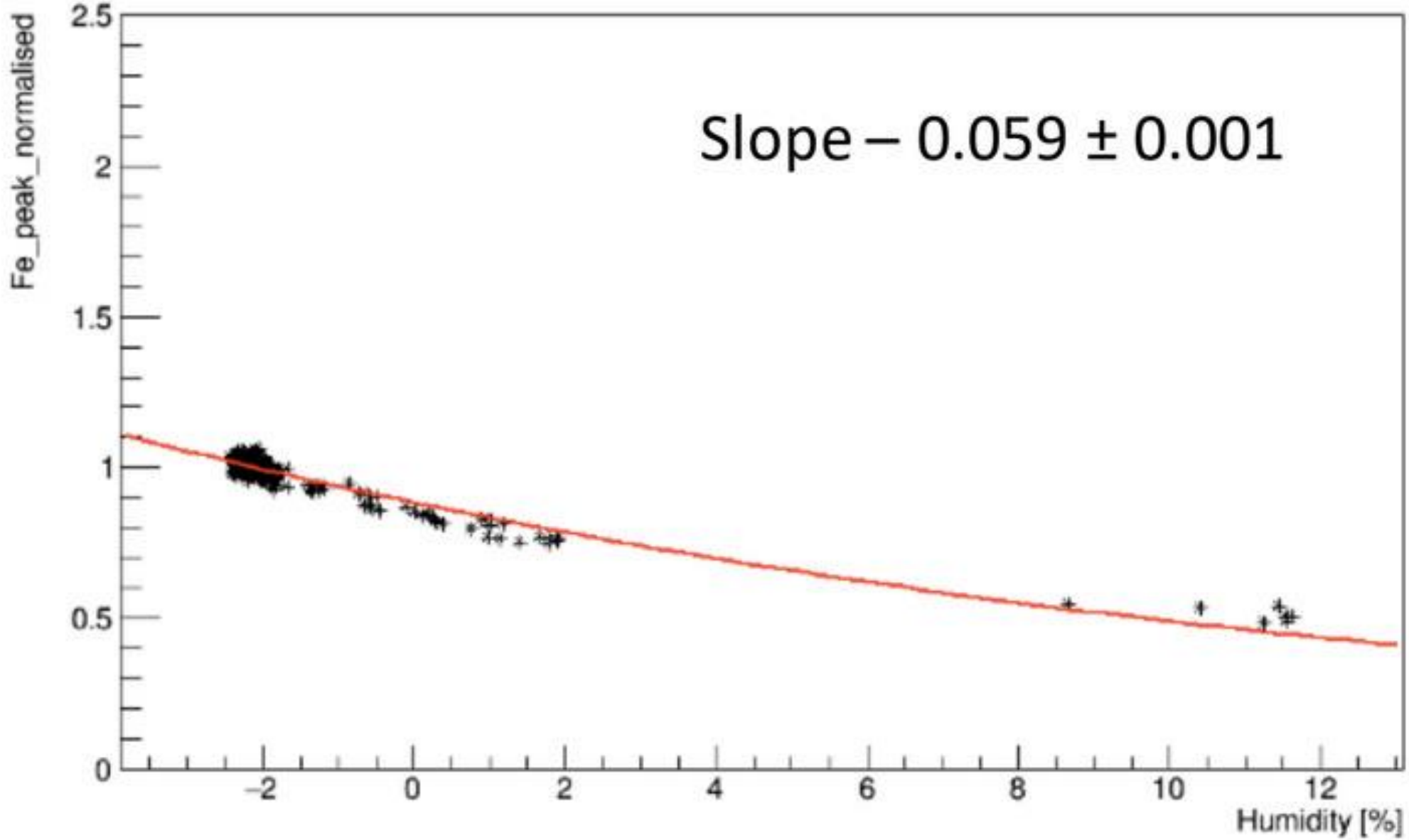
Muons horizontal projection 1.5 kV

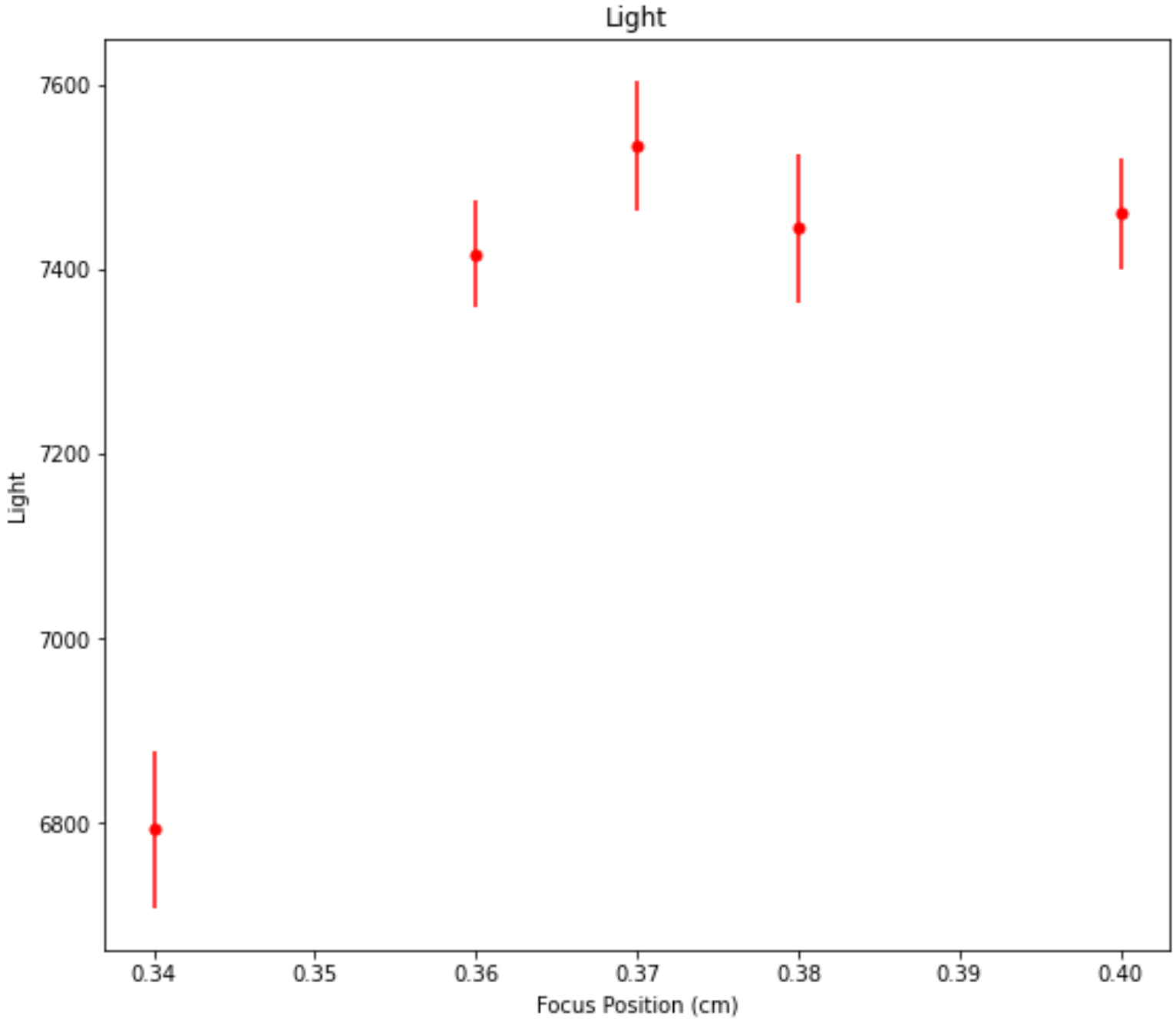


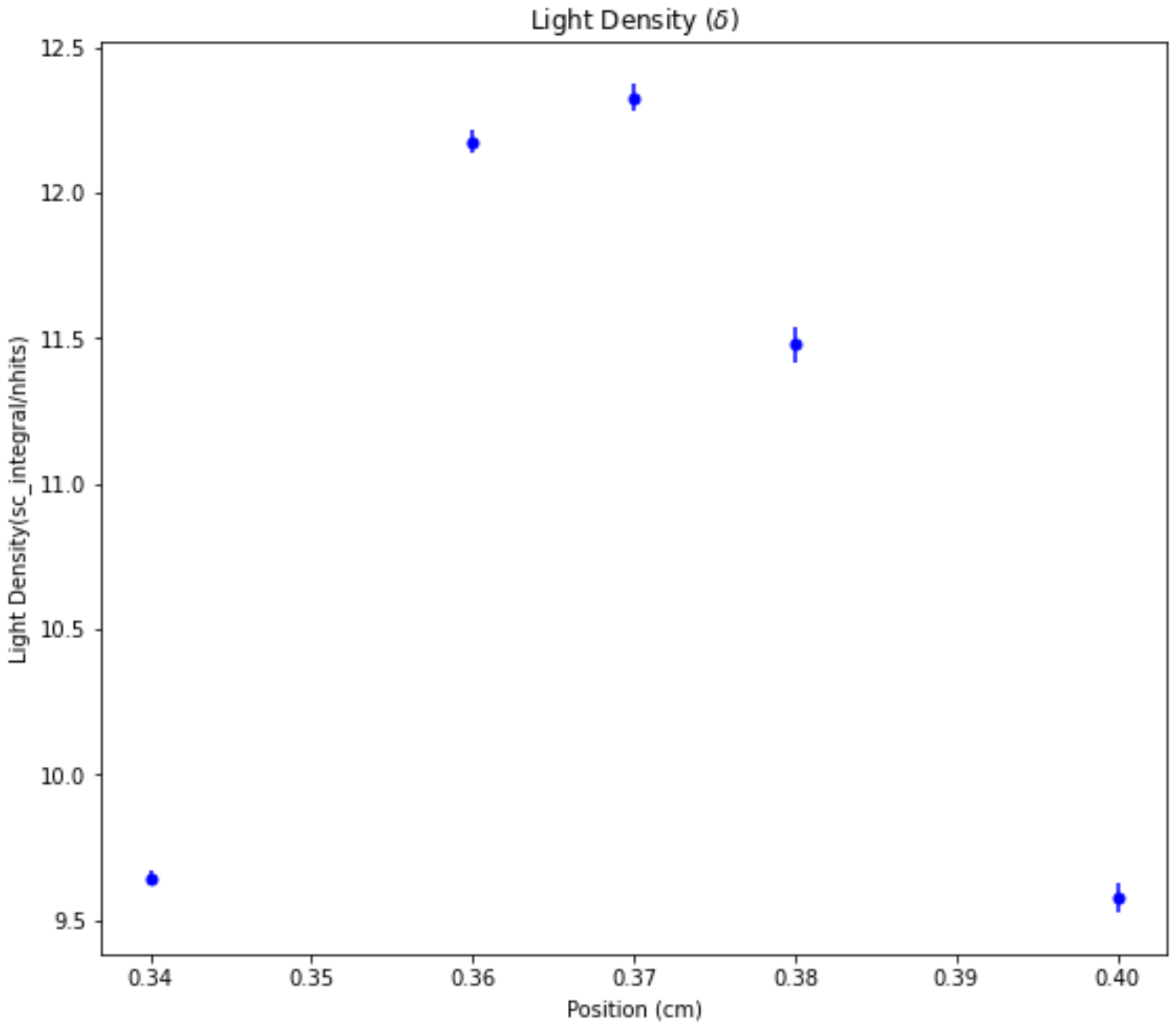
Muons vertical projection 1.5 kV

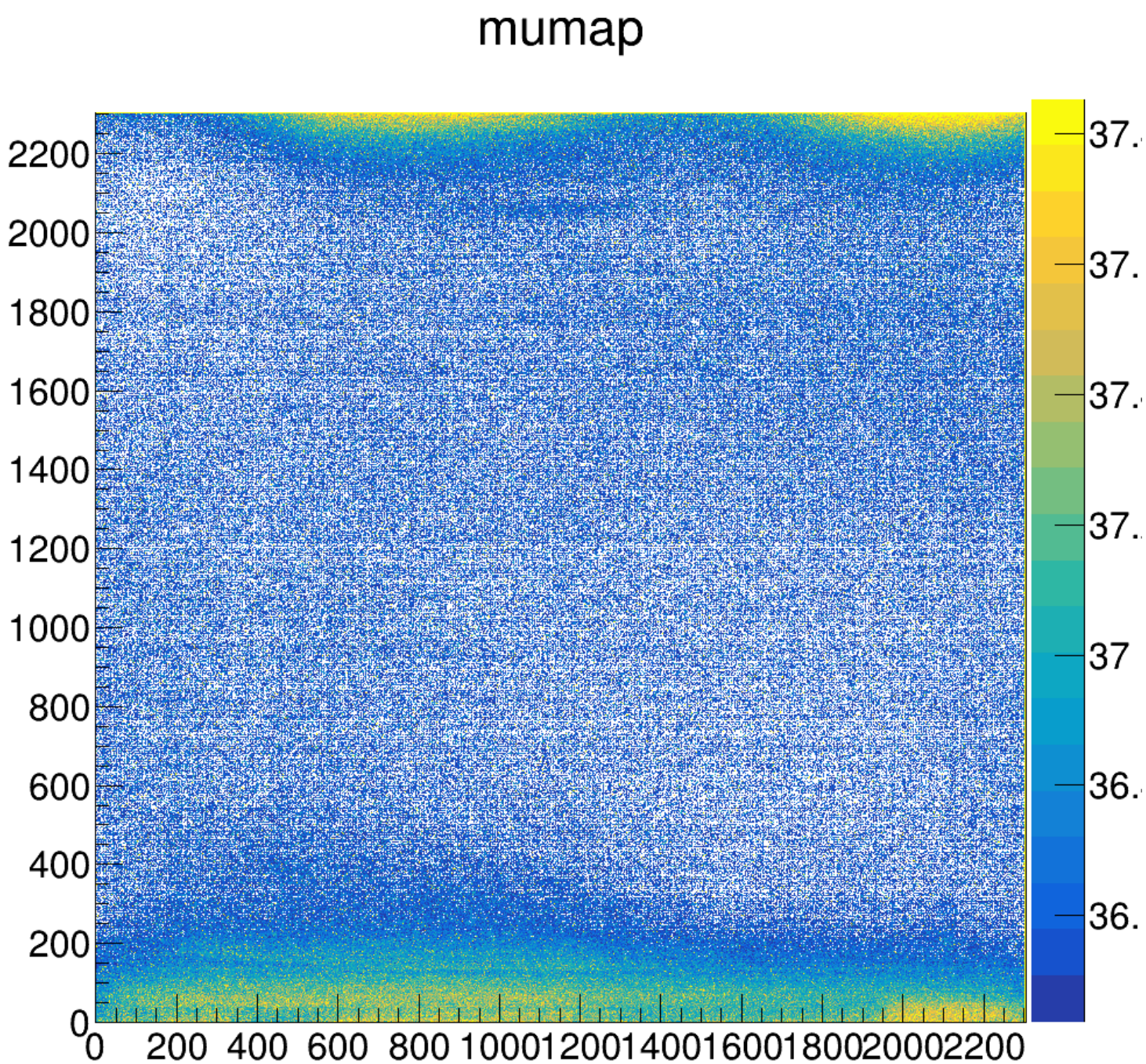


Rita's Light vs Humidity Plot




Light
7600
7400
7200
7000
6800
Light
0.34
0.35
0.36
0.37
0.38
0.39
0.40
Focus Position (cm)


Light Density (δ)
Light Density(sc_integral/nhits)
12.5
12.0
11.5
11.0
10.5
10.0
9.5
0.34
0.35
0.36
0.37
0.38
0.39
0.40
Position (cm)


mumap
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200
37.
37.
37.
37.
37
36.
36.